All India Aakash Test Series for NEET-2023

TEST - 4 (Code-C)

Test Date : 20/02/2022

ANSWERS

1. (1)	41. (3)	81. (2)	121. (4)	161. (3)
2. (3)	42. (4)	82. (4)	122. (4)	162. (4)
3. (4)	43. (1)	83. (3)	123. (1)	163. (3)
4. (2)	44. (4)	84. (1)	124. (4)	164. (4)
5. (3)	45. (2)	85. (2)	125. (3)	165. (1)
6. (4)	46. (1)	86. (2)	126. (4)	166. (2)
7. (2)	47. (3)	87. (4)	127. (2)	167. (3)
8. (2)	48. (4)	88. (2)	128. (1)	168. (4)
9. (4)	49. (3)	89. (3)	129. (1)	169. (2)
10. (3)	50. (2)	90. (2)	130. (1)	170. (1)
11. (2)	51. (2)	91. (3)	131. (3)	171. (2)
12. (3)	52. (4)	92. (1)	132. (2)	172. (2)
13. (1)	53. (2)	93. (1)	133. (1)	173. (4)
14. (3)	54. (4)	94. (2)	134. (2)	174. (4)
15. (1)	55. (3)	95. (3)	135. (4)	175. (2)
16. (3)	56. (3)	96. (1)	136. (1)	176. (3)
17. (4)	57. (4)	97. (3)	137. (3)	177. (4)
18. (1)	58. (1)	98. (2)	138. (1)	178. (4)
19. (4)	59. (3)	99. (2)	139. (4)	179. (1)
20. (3)	60. (1)	100. (4)	140. (2)	180. (2)
21. (4)	61. (4)	101. (2)	141. (3)	181. (3)
22. (4)	62. (3)	102. (3)	142. (3)	182. (1)
23. (2)	63. (3)	103. (3)	143. (1)	183. (2)
24. (1)	64. (4)	104. (1)	144. (3)	184. (2)
25. (3)	65. (1)	105. (4)	145. (2)	185. (2)
26. (3)	66. (2)	106. (1)	146. (2)	186. (2)
27. (3)	67. (3)	107. (3)	147. (4)	187. (4)
28. (4)	68. (2)	108. (1)	148. (1)	188. (4)
29. (2)	69. (2)	109. (4)	149. (2)	189. (2)
30. (3)	70. (2)	110. (3)	150. (1)	190. (2)
31. (2)	71. (2)	111. (1)	151. (2)	191. (4)
32. (1)	72. (3)	112. (4)	152. (2)	192. (1)
33. (2)	73. (2)	113. (2)	153. (3)	193. (4)
34. (4)	74. (1)	114. (4)	154. (2)	194. (2)
35. (2)	75. (3)	115. (4)	155. (3)	195. (3)
36. (3)	76. (4)	116. (2)	156. (3)	196. (4)
37. (3)	77. (3)	117. (2)	157. (4)	197. (2)
38. (4)	78. (3)	118. (3)	158. (2)	198. (3)
39. (4)	79. (2)	119. (4)	159. (1)	199. (3)
40. (2)	80. (1)	120. (2)	160. (2)	200. (2)

HINTS & SOLUTIONS

[PHYSICS]

SECTION - A

1. Answer (1)

Hint: Moment of inertia of ring about centre of mass and perpendicular to plane = MR^2

Sol.: Moment of inertia = Mk^2,

where k is radius of gyration

$\Rightarrow$ $Mk^2 = MR^2$

$\Rightarrow$ $k = R$

2. Answer (3)

Hint: Use parallel and perpendicular axis theorems.

Sol.: Given, $I = \frac{MR^2}{4} + MR^2 = \frac{5}{4}MR^2$

Now, $I' = \frac{MR^2}{2} + MR^2 = \frac{3}{2}MR^2$

$\Rightarrow$ $I' = \frac{3}{2} \times \frac{4I}{5} = \frac{6I}{5}$

3. Answer (4)

Hint: Moment of inertia of a rod about an axis passing through its end = $\frac{Ml^2}{3}$

Sol.: MI of rod about its end = $\frac{Ml^2}{3}$

$\Rightarrow$ $I = \frac{300 \times 10^{-3} \times 400 \times 10^{-4}}{3}$

$\Rightarrow$ $I = 4 \times 10^{-3}$ kg m^2

4. Answer (2)

Hint: Use torque (τ) = $I\alpha$

Sol.: $\alpha = \frac{\Delta\omega}{\Delta t}$

$\Rightarrow$ $\tau = \frac{I\Delta\omega}{\Delta t} = \frac{4 \times 10^2 \times 8}{2}$

$\Rightarrow$ $\tau = 16 \times 10^2$ = 1.6 × 10^3 N m

5. Answer (3)

Hint: Use work done $(W)_{ext} = \Delta U$

Sol.: $U_i = -\frac{GMm}{2R_e}$

$U_f = -\frac{GMm}{4R_e}$

$\Rightarrow$ $\Delta U = -\frac{GMm}{4R_e} - \left(-\frac{GMm}{2R_e}\right) = \frac{GMm}{4R_e}$

6. Answer (4)

Hint: $x_{CM} = \frac{m_1x_1 + m_2x_2 + m_3x_3}{m_1 + m_2 + m_3}$

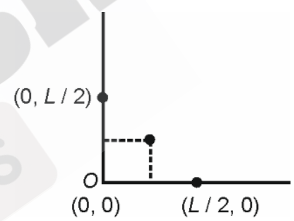
Sol.: $x_{CM} = \frac{M \times R + M \times 3R + M \times 5R}{3M} = \frac{9MR}{3M}$

$x_{CM} = 3R$; $y_{CM} = 0$

7. Answer (2)

Hint: For symmetric body having uniform mass distribution, centre of mass lies at line of symmetry.

Sol.:



$x_{CM} = \frac{M \times \frac{L}{2} + M \times 0}{M + M} = \frac{L}{4}$

$y_{CM} = \frac{M \times 0 + M \times \frac{L}{2}}{M + M} = \frac{L}{4}$

Distance (r) = $\sqrt{\left(\frac{L}{4} - 0\right)^2 + \left(\frac{L}{4} - 0\right)^2} = \frac{L}{2\sqrt{2}}$

8. Answer (2)

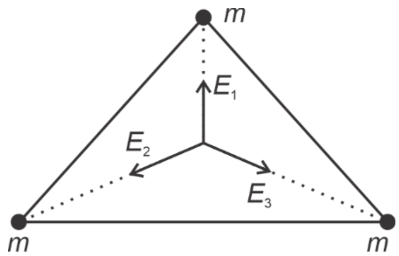
Hint: Use law of conservation of angular momentum.

Sol.: At point B, distance is minimum, hence velocity is maximum using law of conservation of angular momentum.

9. Answer (4)

Hint: Use $\vec{E} = -\frac{GM\vec{r}}{r^3}$

Sol.:



$\vec{E}_{net} = \vec{E}_1 + \vec{E}_2 + \vec{E}_3 = 0$

10. Answer (3)

Hint: Use $g' = \dfrac{g}{\left(1+\dfrac{h}{R}\right)^2}$

Sol.: $g' = \dfrac{gR^2}{(R+h)^2}$

$\Rightarrow \dfrac{g}{2} = \dfrac{gR^2}{(R+h)^2}$

$\Rightarrow R+h = \sqrt{2}R$

$\Rightarrow h = (\sqrt{2}-1)R$

11. Answer (2)

Hint: Use $g' = \dfrac{gR^2}{(R+h)^2}$

Sol.: $g' = \dfrac{gR^2}{(R+h)^2}$

$\Rightarrow g' = \dfrac{gR^2}{4R^2} = \dfrac{g}{4}$ $(\because h = R)$

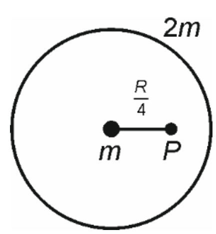
$\Rightarrow W' = mg' = \dfrac{mg}{4} = \dfrac{80}{4} = 20$ N

12. Answer (3)

Hint: Gravitational potential for spherical shell

$= -\dfrac{Gm}{R}(0 < r < R)$

Sol.:



$V_P = -\dfrac{Gm}{R/4} - \dfrac{G(2m)}{R}$

$V_P = -\dfrac{6Gm}{R}$

13. Answer (1)

Hint: Acceleration due to gravity $(g) = \dfrac{GM}{R^2}$

Sol.: $g = -\dfrac{GM}{R^2} \Rightarrow \dfrac{\Delta g}{g} = -\dfrac{2\Delta R}{R}$

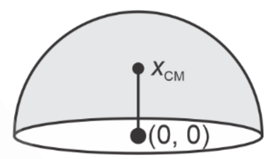
$\dfrac{\Delta g}{g} \times 100 = -2(-2\%)$

$= 4\%$

14. Answer (3)

Hint: Use position of centre of mass for a hollow hemisphere from base $\left(0, \dfrac{R}{2}\right)$.

Sol.:



Position of centre of mass = $\left(0, \dfrac{R}{2}\right) = (0, 10)$ cm

15. Answer (1)

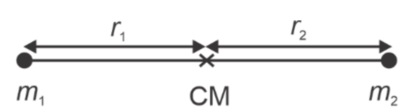
Hint: Use $\vec{v} = \vec{\omega} \times \vec{r}$

Sol.: $\vec{v} = \vec{\omega} \times \vec{r} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 1 & -2 & 1 \\ 2 & 3 & 1 \end{vmatrix} = -5\hat{i} + \hat{j} + 7\hat{k}$

16. Answer (3)

Hint: For two point mass system: $m_1 r_1 = m_2 r_2$

Sol.:



$\Rightarrow m_1 r_1 = m_2 r_2$

$\Rightarrow \dfrac{m_1}{m_2} = \dfrac{r_2}{r_1}$

17. Answer (4)

Hint: Use $\vec{v}_{CM} = \dfrac{m_1\vec{v}_1 + m_2\vec{v}_2}{m_1 + m_2}$

Sol.: Velocity of centre of mass

$\vec{v}_{CM} = \dfrac{m_1\vec{v}_1 + m_2\vec{v}_2}{m_1 + m_2} = \dfrac{4\times 5\hat{i} + 6\times 10\hat{j}}{4+6}$

$\vec{v}_{CM} = \dfrac{20\hat{i} + 60\hat{j}}{10} = 2\hat{i} + 6\hat{j}$

$|\vec{v}_{CM}| = \sqrt{40}$ m/s

18. Answer (1)

Hint & Sol.: Here net external force on system = 0.

So, v_{CM} = constant = 0

19. Answer (4)

Hint: Use result of gravity inside and outside the surface of earth.

Sol.:

$0 \le r < R \quad \Rightarrow \quad E = \frac{GMr}{R^3}$

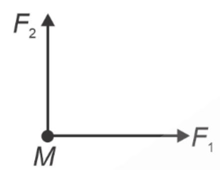
$r = R \quad \Rightarrow \quad E = \frac{GM}{R^2}$

$r > R \quad \Rightarrow \quad E = \frac{GM}{r^2}$

20. Answer (3)

Hint: Use $\vec{F} = -\frac{Gm_1m_2}{r^2}\hat{r}$

Sol.:



$\vec{F}_1 = \frac{GM^2}{(3r)^2}\hat{i}$

$\vec{F}_2 = \frac{GM^2}{(4r)^2}\hat{j}$

$\vec{F} = \frac{GM^2}{r^2}\left(\frac{1}{9}\hat{i} + \frac{1}{16}\hat{j}\right)$

21. Answer (4)

Hint: Use conservation of angular momentum.

Sol.: $I_1\omega_1 = I_2\omega_2$

$\frac{2}{5}MR^2\omega = \frac{2}{5}M\left(\frac{R}{2}\right)^2\omega'$

$\Rightarrow \quad \omega' = 4\omega$

22. Answer (4)

Hint: For equilibrium of a rigid body, resultant torque and force should be zero.

Sol.: Torque due to force (τ) = rF sinθ

Net torque on rod

$(\vec{\tau}) = 20F(\hat{k}) + 120F(-\hat{k}) + 180F(\hat{k}) + 80F(-\hat{k})$

$\Rightarrow \tau_{net} = 0$

So rod remains at rest.

23. Answer (2)

Hint: Use energy conservation principle

Sol.: $U_i + K_i = U_f + K_f$

$-\frac{GMm}{4R} + \frac{1}{2}mv^2 = 0 + 0$

$\Rightarrow$ Energy = $+\frac{GMm}{4R} = +\frac{mgR}{4}$

24. Answer (1)

Hint: Acceleration due to gravity $(g) = \frac{GM}{R^2}$

Sol.: $g_1 = \frac{GM_1}{R_1^2}$ and $g_2 = \frac{GM_2}{R_2^2}$

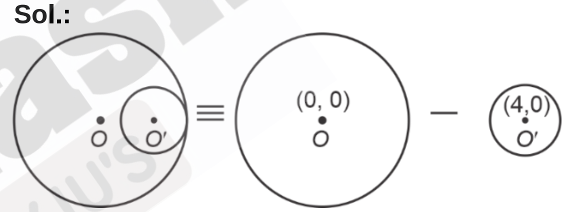
$g_1 = \frac{G \times \rho_1 \times \frac{4}{3}\pi R_1^3}{R_1^2} = \frac{4}{3}\pi G\rho_1 R_1$

$\frac{g_1}{g_2} = \frac{\rho_1 R_1}{\rho_2 R_2} = \frac{1}{2} \times \frac{4}{1} = \frac{2}{1}$

25. Answer (3)

Hint: For cutting of a body (r_{CM}) = $\frac{m_1r_1 - m_2r_2}{m_1 - m_2}$

Sol.:



Mass of complete disc (M_1) = $\rho\pi(6)^2 = m$

Mass of hole (M_2) = $\rho\pi(2)^2 = \frac{m}{9}$

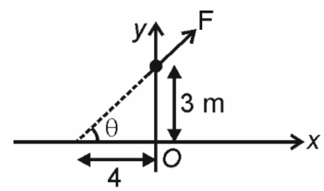
$r_{CM} = \frac{m(0) - \frac{m}{9}(4)}{m - \frac{m}{9}} = -\frac{1}{2}$ cm

26. Answer (3)

Hint:

Angular momentum of particle (L) = $mvr\sin\theta(\hat{n})$

Sol.:



$L = mvr\sin\theta(\hat{n})$

$L_A = mva(-\hat{k})$

$L_B = mva(-\hat{k})$

27. Answer (3)

Hint: $a = \dfrac{g\sin\theta}{1+\dfrac{k^2}{R^2}}$ and $S = ut + \dfrac{1}{2}at^2$

Sol.: For solid cylinder, $\dfrac{k^2}{R^2} = \dfrac{1}{2}$

$$a = \frac{g\sin\theta}{1+\frac{1}{2}}$$

$$a = \frac{2g\sin\theta}{3}$$

$$S = ut + \frac{1}{2}at^2$$

$$l = \frac{1}{2}\left(\frac{2g\sin\theta}{3}\right)t^2$$

$$t = \sqrt{\frac{3l}{g\sin\theta}}$$

28. Answer (4)

Hint: Torque on rigid body (τ) = $I\alpha$

Sol.: Torque (τ) = $I\alpha$ = $I\left(\dfrac{d\omega}{dt}\right)$

$\Rightarrow \quad \theta = 3t^3 - 4t^2$

$\Rightarrow \quad \omega = 9t^2 - 8t$

$\Rightarrow \quad \alpha = 18t - 8$

When $\alpha = 0$; $\tau = 0$

$\Rightarrow \quad t = \dfrac{8}{18} = \dfrac{4}{9}$ s

29. Answer (2)

Hint: Kinetic energy of a rigid body performing rolling motion is $\dfrac{1}{2}mv^2\left(1+\dfrac{k^2}{R^2}\right)$

Sol.: $K_T = \dfrac{1}{2}mv^2$

$$K_R = \frac{1}{2}I\omega^2 = \frac{1}{2}Mk^2\left(\frac{v^2}{R^2}\right)$$

$$\Rightarrow \quad \frac{K_{\text{Rotational}}}{K_{\text{Rolling}}} = \frac{\frac{1}{2}Mv^2\left(\frac{k^2}{R^2}\right)}{\frac{1}{2}Mv^2\left(1+\frac{k^2}{R^2}\right)} = \frac{k^2}{R^2+k^2}$$

For hollow sphere, $k = \sqrt{\dfrac{2}{3}}R$

$$\Rightarrow \quad \frac{K_{\text{Rotational}}}{K_{\text{Rolling}}} = \frac{2}{5}$$

30. Answer (3)

Hint: Torque acting on rigid body (τ) = $I\alpha$

Sol.: $mg - T = ma$ … (1)

$T.R = \dfrac{mR^2}{2} \times \dfrac{a}{R}$ … (2)

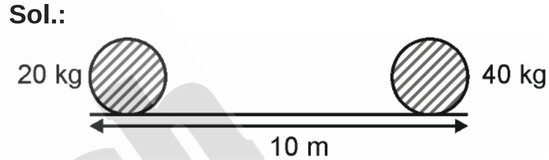
Solving equation (1) and (2)

$\Rightarrow \quad a = \dfrac{2g}{3}$

31. Answer (2)

Hint: Centre of mass of system remains at same position if the net external force is zero.

Sol.:



$20x = 40\ (10 - x)$

$\Rightarrow \quad 20x = 400 - 40x$

$\Rightarrow \quad 60x = 400$

$\Rightarrow \quad x = 6.67$ m

32. Answer (1)

Hint: Use law of conservation of angular momentum principle.

Sol.: On folding his arms, moment of inertia decreases. So angular velocity increases.

33. Answer (2)

Hint: On applying couple, net force on rigid body will be zero.

Sol.:

Net force on rod is zero but net torque is non-zero. So rod will perform rotational motion.

34. Answer (4)

Hint: In sudden compression, angular momentum of rigid body will be conserved.

Sol.: By using conservation of angular momentum

$I_1\omega_1 = I_2\omega_2$

$\Rightarrow \frac{2}{5}MR^2 \times \frac{2\pi}{T} = \frac{2}{5}M \times \frac{R^2}{16} \times \frac{2\pi}{T'}$

$\Rightarrow T' = \frac{T}{16} = \frac{24}{16} = \frac{3}{2}$ hours

35. Answer (2)

Hint: Kinetic energy of body performing rolling motion is $\frac{1}{2}mv^2\left(1+\frac{k^2}{R^2}\right)$

Sol.: Kinetic energy $= \frac{1}{2}mv^2\left(1+\frac{k^2}{R^2}\right)$

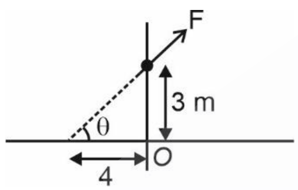
$\Rightarrow \frac{1}{2}\times 10 \times 4\left(1+\frac{2}{5}\right) = 28$ J

SECTION - B

36. Answer (3)

Hint: Torque on the body $(\vec{\tau}) = rF\sin\theta(\hat{n})$

Sol.:



Torque about origin (τ) = $rF\sin\theta$

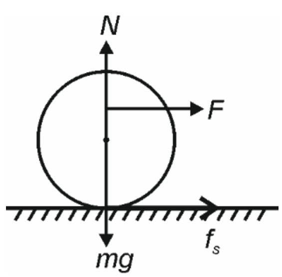
$\Rightarrow \quad \tau = 3 \times 10 \times \sin(90° - \theta)$

$\Rightarrow \quad \tau = 3 \times 10 \times \frac{4}{5} = 24$ Nm

37. Answer (3)

Hint: For pure rolling $a_{com} = R\alpha$

Sol.:



$F + f_s = ma$ ...I

$F\frac{R}{2} - f_s.R = I\alpha$

$\Rightarrow \frac{F}{2} - f_s = \frac{Ia}{R^2}$ ...II

on solving (I) and (II)

$a = \frac{15}{14}\frac{F}{m}$ and $f_s = \frac{F}{14}$

Now $f_s \le f_{s\,max}$

$\Rightarrow \frac{F}{14} \le \mu mg$

$\Rightarrow \mu \ge \frac{F}{14mg}$

$\mu_{min} = \frac{F}{14mg} = \frac{7mg}{14mg} = \frac{1}{2}$

38. Answer (4)

Hint: Gravitational potential $V = \frac{-GM}{r}$

Gravitational potential energy, $U = \frac{-GMm}{r}$

Sol.:

A. Gravitational potential, at centre O,

$V = \frac{-4GM}{r}$

$= \frac{-4 \times G \times 2}{\frac{1}{\sqrt{2}}} = -8\sqrt{2}G$

B. Gravitational potential energy of system.

$U = \frac{-2GM^2}{(\sqrt{2})} - 4\frac{GM^2}{1}$

$= -4\sqrt{2}G - 16G$

$= -4(4+\sqrt{2})G$

C. net gravitational field at centre O is zero

D. Force on mass at point A

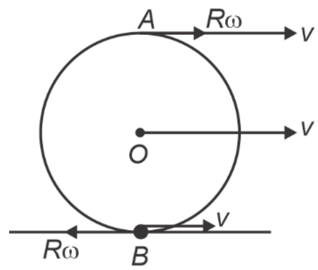
$|\vec{F}_A| = \frac{\sqrt{2}GM^2}{1^2} + \frac{GM^2}{(\sqrt{2})^2}$

$= 4\sqrt{2}G + 2G$

$= (4\sqrt{2}+2)G$

39. Answer (4)

Hint & Sol.:



$v_A = v + R\omega = 2v$

$v_B = v - R\omega = 0$

$v_A - v_B = 2v$

40. Answer (2)

Hint: Torque on rigid body (τ) = $I\alpha$

Sol.: Torque on rigid body (τ) = 100 = 20 α

$\Rightarrow \alpha = 5 = \dfrac{\Delta\omega}{\Delta t}$

$\omega = \omega_0 + \alpha t$

$\Rightarrow \omega = 0 + 5 \times 4 = 20$ rad/s

41. Answer (3)

Hint: Use power (P) = $\vec{\tau}.\vec{\omega}$

Sol.: Power of rotating body (P) = $\tau\omega$

$\Rightarrow \tau = \dfrac{P}{\omega} = \dfrac{50}{4} = 12.5$ N m

42. Answer (4)

Hint: Use orbital velocity of satellite $(v_o) = \sqrt{\dfrac{GM}{r}}$

Sol.: $\dfrac{v_{o_1}}{v_{o_2}} = \sqrt{\dfrac{r_2}{r_1}} = \sqrt{\dfrac{2}{3}} \Rightarrow v_{o_1} = \sqrt{\dfrac{2}{3}}v$

43. Answer (1)

Hint: Use energy conservation principle

Sol.: $U_i + K_i = U_f + K_f$

$\dfrac{-GMm}{R} + \dfrac{1}{2}mv_e^2 = 0 + 0$

$\Rightarrow v_e = \sqrt{\dfrac{2GM}{R}}$

(independent of angle of projection)

44. Answer (4)

Hint: Use time period of simple pendulum $(T) = 2\pi\sqrt{\dfrac{l}{g}}$

Sol.: In orbiting satellite; $g_{\text{eff}} = 0$

So, $T = 2\pi\sqrt{\dfrac{l}{0}} = \infty$

45. Answer (2)

Hint: Use time period of satellite $T^2 \propto r^3$

Sol.: Time period of satellite $(T) = 2\pi\sqrt{\dfrac{r^3}{GM}}$

Potential energy of satellite $(U) = \dfrac{-GMm}{r}$

$\Rightarrow T^2 \propto r^3 \propto \dfrac{1}{U^3}$

46. Answer (1)

Hint: Use escape velocity $v_e = \sqrt{\dfrac{2GM}{R}}$ and $U = \dfrac{-GMm}{R}$

Sol.: $v_e = \sqrt{\dfrac{2GM}{R}} = 50 \text{ m s}^{-1}$

$\Rightarrow \dfrac{2GM}{R} = 2500$

$\Rightarrow U = \dfrac{-GMm}{R} = -\dfrac{2500 \times 1}{2} = -1250$ J

47. Answer (3)

Hint & Sol.: $v > \sqrt{2}\, v_{\text{orbital}}$, so satellite will escape with hyperbolic path.

48. Answer (4)

Hint: $\vec{a}_{\text{cm}} = \dfrac{m_1\vec{a}_1 + m_2\vec{a}_2}{m_1 + m_2}$

Sol.: As $a = \left(\dfrac{m_1 - m_2}{m_1 + m_2}\right)g = \dfrac{4-2}{4+2} \times 10 = \dfrac{10}{3}$ m/s^2

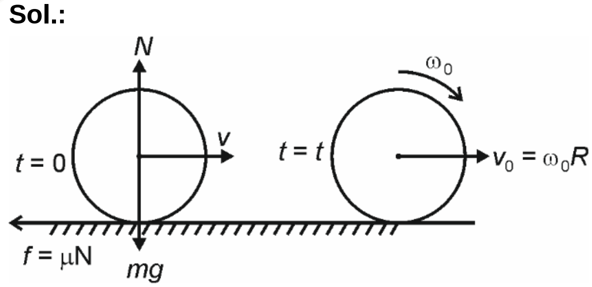
$\vec{a}_{\text{cm}} = \dfrac{2\times\left(\dfrac{10}{3}\hat{j}\right) + 4\left(-\dfrac{10}{3}\hat{j}\right)}{2+4} = \dfrac{\dfrac{20}{3}\hat{j} - \dfrac{40}{3}\hat{j}}{6}$

$= \left(-\dfrac{10}{9}\hat{j}\right)$ m/s^2

49. Answer (3)

Hint: Disc will perform rolling with forward slipping initially

Sol.:



$f = \mu N = ma$

$\Rightarrow a = \mu g$, retardation

So, $v_0 = v - at$

$\Rightarrow v_0 = v - \mu gt$

Now $\tau = I\alpha$

$\Rightarrow \mu NR = \dfrac{MR^2}{2}\alpha$

$\Rightarrow \alpha = \dfrac{2\mu g}{R}$

So, $\Rightarrow \omega_0 = \alpha t$

$$\Rightarrow \frac{v_0}{R} = \frac{2\mu g t}{R}$$

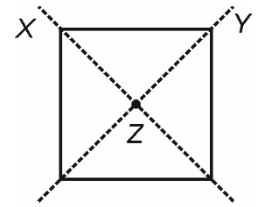
$$\Rightarrow v - \mu g t = 2\mu g t$$

$$\Rightarrow t = \frac{v}{3\mu g}$$

50. Answer (2)

Hint: Diagonals of square intersect each other at right angle.

Sol.: $I_z = I_x + I_y$



$$\frac{ma^2}{6} = 2I_y \quad (\because\ I_x = I_y)$$

$$\Rightarrow I_y = \frac{ma^2}{12}$$

[CHEMISTRY]

SECTION - A

51. Answer (2)

Hint and Sol.: Dipole-dipole interaction energy between stationary polar molecules in solids $\propto \frac{1}{r^3}$.

52. Answer (4)

Hint and Sol.: Due to presence of large inter-molecular distances among gas molecules, gases generally possess larger volume and smaller density than both solids and liquids.

53. Answer (2)

Hint: Both at STP and SATP, pressure is 1 bar.

Sol.: At SATP, P = 1 bar and T = 298.15 K

54. Answer (4)

Hint: $P_{He} = P_T \times X_{He}$

Sol.: If masses of both He and Ne gases are w(g) then

$$X_{He} = \frac{\frac{w}{4}}{\frac{w}{4} + \frac{w}{20}} = \frac{5}{5+1} = \frac{5}{6}$$

$$P_{He} = P_T X_{He} = \frac{5}{6} \times 18 = 15 \text{ atm}$$

55. Answer (3)

Hint: During random motion of gas particles, they collide with each other and with the walls of the container.

Sol.: Pressure of gas is due to collisions of molecules with the wall of the container.

56. Answer (3)

Hint: Correction term of pressure for real gas molecules is $\frac{an^2}{V^2}$

Sol.: Unit of correction term of pressure is the unit of pressure i.e. atm.

57. Answer (4)

Hint: Normal boiling point of water = 100°C

Standard boiling point of water = 99.6°C

Sol.: Difference of normal and standard boiling point of water = 100 – 99.6 = 0.4°C

58. Answer (1)

Hint: Force $(F) = \eta A \frac{dv}{dz}$

Sol.: Unit of coefficient of viscosity (η) is $Nm^{-2}s$ or Pa s

59. Answer (3)

Hint: Stronger the intermolecular forces, higher is the temperature required to maintain a constant vapour pressure.

Sol.: Due to presence of H-bonding in water, it has strongest intermolecular forces, so it requires highest temperature to achieve a given vapour pressure among the given options.

60. Answer (1)

Hint: Both ionization energy and binding energy terms are used for removal of an electron from an atom.

Sol.: The energy required to increase the surface area of liquid by 1 unit is known as surface energy.

61. Answer (4)

Hint: Pair of non-polar molecules have only dispersion forces.

Sol.: Both Cl_2 and Ne are non-polar molecules, so interact only by dispersion forces.

62. Answer (3)

Hint: Average kinetic energy (for n mole gas) $= \frac{3}{2}nRT$

Sol.: Average kinetic energy for He(g)

$$=\frac{3}{2}\times1\times R\times400$$

= 600 R

63. Answer (3)

Hint: Greater is the intermolecular forces among molecules, higher is the value of surface tension of liquid.

Sol.:

- Due to presence of more H-bonding, H_2O has highest intermolecular forces and correspondingly highest surface tension.
-

Liquid	Surface tension (dyn cm^{-1}) (At 20°C)
H_2O	72.8
CH_3OH	22.55
CS_2	32.25
C_6H_6	28.87

64. Answer (4)

Hint: Density of an ideal gas $=\frac{PM}{RT}$

Sol.: $d=\frac{PM}{RT}=\frac{2\text{ atm}\times16\text{ g mol}^{-1}}{0.0821\text{ L-atm K}^{-1}\text{mol}^{-1}\times600\text{K}}$

= 0.65 g/L

65. Answer (1)

Hint: $\Delta_{vap}S=\frac{\Delta_{vap}H}{T_{B.P.}}$

Sol.: $\Delta_{vap}S=\frac{40.66\times10^3}{373}=109\text{ J K}^{-1}\text{ mol}^{-1}$

66. Answer (2)

Hint and Sol.: For adiabatic process, q = 0.

67. Answer (3)

Hint: Enthalpy of neutralization of 1 equivalent strong acid with 1 equivalent of strong base is –57.1 kJ.

Sol.: Enthalpy change when 0.5 equivalents of H_2SO_4 and NaOH, neutralization each other is

(ΔH) = – 0.5 × 57.1 kJ

68. Answer (2)

Hint: PV = nRT

Sol.: PV = nRT

P × 20 L = 0.25 mol × 0.0821 L-atm mol^{-1} K^{-1} × 400 K

($\because$ V = 0.02 m^3 = 20 L)

P = 0.41 atm

69. Answer (2)

Hint: Root mean square speed (U_{rms}) = $\sqrt{\frac{3RT}{M}}$

Sol.: $U_{rms}=\sqrt{\frac{3\times8.314\times300}{64\times10^{-3}}}$

= 341.9 m/s

$\simeq$ 342 m/s

70. Answer (2)

Hint: With increase in molar mass, van der Waals forces increases and value of ‘a’ generally increases.

Sol.: Order of van der Waals constant ‘a’:

$CO_2 > CH_4 > O_2 > N_2$

Due to more interaction forces CO_2(g) show more negative deviation.

71. Answer (2)

Hint: Compressibility factor (Z) = $\frac{V_{Real}}{V_{Ideal}}$

Sol.: $\therefore$ V_{Real} = 1.2 V_{Ideal}, $Z=\frac{1.2\ V_{Ideal}}{V_{Ideal}}=1.2$

Hence, Z > 1 and in this condition repulsive forces are dominant.

72. Answer (3)

Hint: Boyle’s temperature $(T_B)=\frac{a}{Rb}$, and

Critical temperature $(T_C)=\frac{8a}{27Rb}$

Sol.: $T_B=\frac{a}{Rb}=540\text{ K}$

$T_C=\frac{8}{27}\left(\frac{a}{Rb}\right)=\frac{8}{27}\times540$

= 8 × 20

= 160 K

73. Answer (2)

Hint: For a gas: $U_{mps} < U_{avg} < U_{rms}$

Sol.:

- Boyle’s temperature depends on the nature of gas.
- Area under the Maxwell curve is equal to unity which is independent of the nature of gas.
- Minimum pressure required for liquifaction of gas at critical temperature is known as critical pressure.

74. Answer (1)

Hint: Molar properties are intensive in nature.

Sol.: Resistance is an extensive property.

75. Answer (3)

Hint: $G = H - TS$

Sol.: G is a state function and state functions depend only on the state of the system not how it is reached.

76. Answer (4)

Hint: $\Delta G = \Delta H - T\Delta S$

The reaction will be spontaneous, if $\Delta G < 0$

Sol.: If $\Delta H < 0$ and $\Delta S > 0$, then $\Delta G < 0$ at all temperatures.

77. Answer (3)

Hint: Molar heat capacity = $\frac{1}{n}\frac{dQ}{dT}$

Sol.: For isothermal process, $dT = 0$

So, molar heat capacity will be infinite.

78. Answer (3)

Hint and Sol.: Enthalpy change during conversion of 1 mole species into gaseous atom is equal to enthalpy of atomisation.

79. Answer (2)

Hint: Standard state of O_2 is gas.

Sol.: Elements present in standard state have its enthalpy of formation as zero

So, $\Delta_f H°(O_2(l)) \neq 0$

80. Answer (1)

Hint: Entropy order: Solid < Liquid < Gas

Sol.:

- Melting of gallium results in increase of entropy.
- Dimerisation of benzoic acid, liquifaction of $N_2(g)$ and formation of NH_3 by using $N_2(g)$ and $H_2(g)$ have $\Delta S < 0$.

81. Answer (2)

Hint: For irreversible expansion,

$W = -P_{ext}(V_f - V_i)$

Sol.: $W = -2$ atm $(20 - 10)$ L

$= -2 \times 10$ L - atm

$= -20$ L - atm

82. Answer (4)

Hint: For all gases, ratio of $\frac{C_p}{C_v}$ is independent of R.

Sol.: For monoatomic gas, $\frac{C_p}{C_v} = \frac{5}{3}$

83. Answer (3)

Hint: $CH_4(g)$ has four 'C – H' bonds.

Sol.: For $CH_4(g) \longrightarrow C(g) + 4H(g)$

$\Delta H_r = 4BE(C-H)$

$\therefore\ BE(C-H) = \frac{\Delta H_r}{4} = \frac{1665}{4} = 416.25\ \text{kJ mol}^{-1}$

84. Answer (1)

Hint: $\Delta H_C(H_2(g)) = \Delta_f H(H_2O(l))$

Sol.:

- No. of moles in 3.6 g of $H_2O(l) = \frac{3.6}{18} = 0.2$ mol
- So, heat released for formation of 0.2 mol $H_2O(l) = 0.2 \times (-285.8) = -57.16$ kJ

85. Answer (2)

Hint: $\Delta H_{rxn} = \sum BE\,(\text{Reactant}) - \sum BE\,(\text{Product})$

Sol.: $\frac{1}{2}A_2 + \frac{1}{2}B_2 \longrightarrow AB$

$\Delta H_{rxn} = \frac{1}{2}(2x) + \frac{1}{2}(1.5x) - 2x$

$= x + 0.75x - 2x = -0.25x = -300$

So, $x = 1200$

Hence, bond dissociation energy of B_2

$= 1.5 \times 1200 = 1800\ \text{kJ mol}^{-1}$

SECTION - B

86. Answer (2)

Hint: At constant temperature, $P_1V_1 = P_2V_2$

Sol.:

- $P_1 = 740$ mm Hg, $V_1 = 400$ ml
- $P_2 = 800$ mm Hg, $V_2 = ?$
- $P_1V_1 = P_2V_2 \Rightarrow 740 \times 400 = 800 \times V_2$

  $V_2 = 370$ ml

87. Answer (4)

Hint: Gases do not have a definite shape and volume.

Sol.:

- Increase of pressure increases the boiling point of liquids and this concept involves in pressure cooker.
- Expansion of gas at constant temperature does not result in increase of number of gas molecules.

88. Answer (2)

Hint: Rate of effusion (r) $\propto \left(\frac{1}{\text{Molar mass}}\right)^{\frac{1}{2}}$

$$\propto \frac{1}{\text{time}}$$

Sol.: $\frac{r_1}{r_2}=\frac{t_2}{t_1}=\sqrt{\frac{M_2}{M_1}} \Rightarrow 4=\sqrt{\frac{M_2}{2}}$

$M_2 = 16 \times 2 = 32$ g mol^{-1}

So, possible formula of gas is $O_2(g)$.

89. Answer (3)

Hint: $\Delta G° = -2.303\ RT\ \log K_p$

Sol.: $\Delta G° = -2.303 \times 8.314 \times 298 \times \log 100$

90. Answer (2)

Hint: $\Delta H = \Delta E + \Delta n_g RT$

Sol.: For given reaction, $\Delta n_g = 3$

So, $\Delta H = \Delta E + 3 \times R \times 300$

Or $\Delta H - \Delta E = 900R$

91. Answer (3)

Hint: At equilibrium, $\Delta G = 0$

Sol.: At equilibrium, entropy is maximum while Gibbs' free energy change is zero.

92. Answer (1)

Hint: With increase of temperature, randomness of ideal gases increases.

Sol.: Smaller is the value of pressure, higher will be the randomness. So, at 1 atm pressure and at 373°C, randomness will be highest.

93. Answer (1)

Hint: Entropy change,

$$\Delta S = nC_V \ln\left(\frac{T_2}{T_1}\right) + nR\ln\left(\frac{V_2}{V_1}\right)$$

Sol.: For isothermal process, $T_2 = T_1$

So, $\Delta S = nR\ln\left(\frac{V_2}{V_1}\right)$

94. Answer (2)

Hint: Thermochemical reactions can be added or subtracted algebraically on the basis of ΔH.

Sol.: Applying 3(i) + (ii) – (iii)

$2A \longrightarrow E + 4C$,

$\Delta H = 900 - 120 - 500 = 280$ kJ mol^{-1}

95. Answer (3)

Hint: ΔG is an additive property.

Sol.:

(i) $A \longrightarrow B$, $\Delta G_1 = -700$ kcal

(ii) $C \longrightarrow B$, $\Delta G_2 = +800$ kcal

on applying (i) – (ii), $A \longrightarrow C$, $\Delta G = -1500$ kcal

96. Answer (1)

Hint: Enthalpy of neutralization of strong acid with strong base is –57.1 kJ eqv^{-1}.

Sol.: Ionization enthalpy of weak monoacidic base = – 47.1 – (– 57.1)

= – 47.1 + 57.1

= 10 kJ mol^{-1}

97. Answer (3)

Hint: NaCl is solid, H_2O is liquid while NH_3 is gas at room temperature.

Sol.: Order of enthalpy of vapourization,

$NH_3 < H_2O < NaCl$

98. Answer (2)

Hint: $\Delta G = \Delta G° + 2.303\ RT\log Q$ and

$\Delta G° = -RT\ln K$

Sol.:

- $\Delta G° = \Delta H° - T\Delta S° = -RT\ln K$
- $\Delta G = \Delta G° + RT\ln Q$

$= -RT\ln K + RT\ln Q = -RT\ln\left(\frac{K}{Q}\right)$

- $\Delta G° = -RT\ln K_P \Rightarrow K_P = e^{-\Delta G°/RT}$

99. Answer (2)

Hint: $\Delta G° = \Delta H° - T\Delta S°$ and $\Delta H° = \Delta U° + \Delta n_g RT$

Sol.:

- $\Delta H° = \Delta U° + \Delta n_g RT$

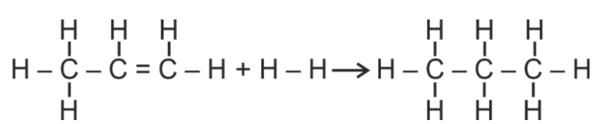
  $= -10 + (0)RT = -10$ kJ

- $\Delta G° = -10 - 298 \times 10^{-3} \times (-40) = 1.92$ kJ

100. Answer (4)

Hint: $\Delta_r H = \sum BE\ (\text{Reactants}) - \sum BE\ (\text{Products})$

Sol.:



$\Delta_r H$ = {6BE (C – H) + BE (C – C) + BE (C = C)

+ BE (H – H)} – {8BE (C – H) + 2BE (C – C)}

= BE (C = C) + BE (H – H) – 2BE (C – H)

– BE (C – C)

= 600 + 430 – 2 × 410 – 330

= –120 kJ mol^{-1}

[BOTANY]

SECTION - A

101. Answer (2)

Hint: Cells of pith in primary stems and roots are thin walled.

Sol.: Parenchymatous cells are usually present in cortex, pericycle, pith and medullary rays, in the primary stems and roots.

102. Answer (3)

Hint: Secondary growth occurs when the vascular bundles are open.

Sol.: Open vascular bundles have cambium between xylem and phloem. Such vascular bundles because of the presence of cambium possess the ability to form secondary xylem and phloem tissues, and hence are called open vascular bundles.

103. Answer (3)

Hint: Conjunctive tissue is present in between the patches of xylem and phloem.

Sol.: The parenchymatous cells which lie between the xylem and the phloem of both monocotyledonous and dicotyledonous roots are called conjunctive tissue.

104. Answer (1)

Hint: Interfascicular cambium lies between two intrafascicular cambia.

Sol.: In dicotyledonous stem, the cells of medullary rays, adjoining the two intrafascicular cambia become meristematic and form the interfascicular cambium.

105. Answer (4)

Hint: Heartwood comprises of dead elements with highly lignified walls.

Sol.: The heartwood does not conduct water but it gives mechanical support to the stem. Deposition of organic compounds like tannins, resins, oils, gums, aromatic substances and essential oils in heartwood make it hard, durable and resistant to the attacks of microorganisms and insects.

106. Answer (1)

Hint: Carbohydrate in the form of sucrose which is soluble in water is transported in plants through phloem.

Sol.: Phloem sap is mainly water and non-reducing sugar *i.e.*, sucrose. Hormones, amino acids and other sugars are also translocated through phloem.

107. Answer (3)

Hint: Proteins form channels in the membrane of some cell organelles and some bacteria, allowing molecules to pass through.

Sol.: The porins are proteins that form large pores in the membranes of the plastids, mitochondria and some bacteria.

108. Answer (1)

Hint: In symport, molecules move in the same direction.

Sol.: Symport is the transport of two types of molecules across the membrane in the same direction.

109. Answer (4)

Hint: In active transport, materials move across the membrane with the help of mobile carrier protein and ATP.

Sol.: In active transport, pumps transport substances from their low concentration to high concentration *i.e.*, against concentration gradient. So, it is an uphill transport.

110. Answer (3)

Hint: Along with inorganic nutrients, xylem transports organic materials too.

Sol.: Small amount of phosphorus and sulphur as organic compounds transport through xylem.

111. Answer (1)

Hint: Cell of inner boundary of the cortex have many transport proteins.

Sol.: Transport proteins of endodermal cells are control points, where plants can adjust the quantity and type of solutes that reach the xylem according to its variable requirement.

112. Answer (4)

Hint: Minerals are present in the soil as charged ions.

Sol.: Minerals are absorbed by the roots actively because they are present in soil in lower concentration and as charged ions.

113. Answer (2)

Hint: Water potential of pure water at standard temperature, which in not under any pressure is taken to be zero.

Sol.: Solute potential of a solution is always negative. For a solution at atmospheric pressure, water potential is equal to solute potential. If the pressure greater than atmospheric pressure is applied to a solution, its water potential increases.

114. Answer (4)

Hint: Water moves from its higher water potential to its lower water potential.

Sol.: According to the question

$\Psi_w(A) = -7 + 2 = -5$ bar

$\Psi_w(B) = -9 + 3 = -6$ bar

As the water flows from both cell A and cell B to cell C, the water potential of cell C should be the lowest.

The value of Ψ_w in option (4) is the lowest *i.e.*, $-9 + 2 = -7$ bar.

115. Answer (4)

Hint: Osmosis is a special type of diffusion.

Sol.: Osmosis is a special type of diffusion of water across a differentially or semipermeable membrane. The plant cell wall is freely permeable to water and substances in a solution.

116. Answer (2)

Hint: Osmotic pressure is equivalent to the osmotic potential, but the sign is opposite.

Sol.: Factors such as concentration of solute particles, ionization of the solute molecule, temperature etc. affect the osmotic pressure.

117. Answer (2)

Hint: Plant cell wall is permeable to the solution.

Sol.: As the plasmolysed plant cell is placed in hypotonic solution, the solute of solution present between cell wall and plasma membrane will move towards the solution A due to permeability of cell wall.

118. Answer (3)

Hint: Intercalary meristem is a primary meristem.

Sol.: Intercalary meristem is found intercalated between two permanent tissues and they increase length of plant.

119. Answer (4)

Hint: Cells of shoot apical meristem left in axil, called axillary meristem.

Sol.: Axillary bud is primary meristem and can form a flower or branch of stem.

120. Answer (2)

Hint: Lateral meristem are mostly secondary in origin.

Sol.: Intrafascicular meristem is a primary meristem. Rest all are secondary meristems.

121. Answer (4)

Hint: Mechanical tissues can be living or dead.

Sol.: Collenchyma is living mechanical tissue of plants.

122. Answer (4)

Sol.: Sclereids provide gritty texture to fruits.

123. Answer (1)

Hint: Protoxylem and metaxylem both are primary xylems.

Sol.: Metaxylem is mature primary xylem with wider lumen.

124. Answer (4)

Hint: Bast fibre is another name of phloem fibre.

Sol.: In phloem, sieve tubes, companion cells and phloem parenchyma are living while phloem fibre is dead. In xylem only ray parenchyma is living.

125. Answer (3)

Hint: Trichome and root hair both are epidermal outgrowths.

Sol.: Trichomes are soft or stiff, unicellular or multicellular epidermal outgrowths.

126. Answer (4)

Hint: Casparian strips makes endodermis impervious to water.

Sol.: Casparian strips are seen in roots only.

127. Answer (2)

Hint: Open vascular bundles have cambium.

Sol.: Dicot stem has conjoint, collateral open vascular bundles.

128. Answer (1)

Hint: Ground tissue is not differentiated in monocot stem.

Sol.: Dicot stem has vascular bundles arranged in a ring while in monocot stem, they are scattered.

129. Answer (1)

Hint: Isobilateral leaves are found in monocots.

Sol.: Isobilateral leaves have stomata on both the surfaces. They have bundle sheath cells and have cuticle on epidermis.

130. Answer (1)

Sol.: Bulliform cells are empty, colourless cells of upper epidermis of monocot leaves.

131. Answer (3)

Hint: Secondary growth in root is not affected by seasonal pattern.

Sol.: Spring wood is also called early wood and it has lesser density.

132. Answer (2)

Hint: Phellogen is extra-stelar cambium.

Sol.: Phellogen is formed by dedifferentiation of the cell of cortex.

133. Answer (1)

Hint: Stomata are also found in monocots.

Sol.: Both stomata and lenticels are involved in loss of water in the form of vapour. They are also involved in gaseous exchange.

134. Answer (2)

Hint: Heartwood is also called duramen.

Sol.: Duramen is centrally located secondary xylem.

135. Answer (4)

Hint: All tissues outside vascular cambium constitute bark.

Sol.: Bark does not include xylem. It includes cork cambium, pericycle and phellem.

SECTION - B

136. Answer (1)

Hint: Imbibition is a special type of diffusion.

Sol.: In imbibition, molecules move from its higher concentration to its lower concentration. This process does not require the energy of ATP.

137. Answer (3)

Hint: In flaccid condition of a cell, its DPD = OP.

Sol.: The relation among DPD, OP and TP is DPD = OP – TP.

138. Answer (1)

Hint: Cork cambium is extra-stelar cambium.

Sol.: Cork cambium or phellogen also known as extra-stelar cambium, develops usually in the cortex region during secondary growth in dicotyledonous plants.

139. Answer (4)

Hint: The cells of the endodermis in stem are rich in starch grains.

Sol.: In dicotyledonous stem, the cells in the innermost layer of the cortex called the endodermis are rich in starch grains and this layer is also referred to as the starch sheath.

140. Answer (2)

Hint: Bulliform cells are found in grasses. These are certain adaxial epidermal cells along the veins which modify themselves into large, empty, colourless cells.

Sol.: When the bulliform cells in the leaves absorbs water and become turgid, the leaf surface is exposed. When they become flaccid due to water stress, they make the leaves curl inwards to minimise water loss.

141. Answer (3)

Hint: Apoplast pathway includes non-living parts of plant body.

Sol.: Symplastic pathway of water movement includes living parts of plant body. It is slightly slower pathway.

142. Answer (3)

Hint: Casparian strips are present in the endodermis.

Sol.: The inner boundary of the cortex *i.e.*, endodermis is impervious to water because of a band of suberized matrix called the casparian strip.

143. Answer (1)

Hint: Guttation occurs when the root pressure is high and transpiration is low.

Sol.: The process of exudation of liquid drops from the margin of the leaves is called guttation.

144. Answer (3)

Hint: There is more attraction between molecules in liquid phase as compared to gas phase.

Sol.: Surface tension is created by the attraction between molecules. The force of attraction between molecules in liquid phase is more than in gas phase. Therefore, the surface tension is more in liquid phase as compared to gas phase.

145. Answer (2)

Hint: Translocation of food from leaves to other parts of plants occurs through phloem.

Sol.: Transport of minerals and water that occurs through xylem is due to transpiration. Due to this process, water supply for photosynthesis is maintained. It also lowers the temperature of leaf surface.

146. Answer (2)

Hint: Roots are underground parts of plant.

Sol.: Outside of the epidermis is often covered with cuticle in aerial parts of plants. This covering of cuticle is absent in roots.

147. Answer (4)

Hint: Epidermis of root is also called epiblema. Bulliform cells are colourless.

Sol.: Guard cells possess chloroplasts and regulate the opening and closing of stomata.

148. Answer (1)

Hint: Complementary cells are loosely-arranged thin-walled parenchymatous cells present in lenticels.

Sol.: Cork cambium some times produces complementary cells instead of thick walled cork cells. The increased number of such type of cells forms lenticels.

149. Answer (2)

Hint: Tyloses are tracheal plugs found in heartwood.

Sol.: Tyloses are balloon-like swellings of xylem parenchyma cells in the lumen of vessels.

150. Answer (1)

Hint: Pericycle is outer most layer of stele.

Sol.: In monocots, pericycle forms lateral roots only. Monocots lack cambium.

[ZOOLOGY]

SECTION - A

151. Answer (2)

Hint: Feeding

Sol.:

- In *Paramoecium*, cilia helps in locomotion as well as movement of food through cytopharynx.
- Pseudopodia are formed by the streaming of protoplasm, e.g., *Amoeba.*
- Tentacles are not found in *Paramoecium.* Tentacles help in locomotion and capturing of prey in *Hydra*.
- Cytoskeletal elements are involved in amoeboid movement.

152. Answer (2)

Hint: Change in place or location of whole organism is called locomotion.

Sol.: All locomotions are movements but all movements are not locomotions. The voluntary movements which result in change of place or location of whole organism is called locomotion.

153. Answer (3)

Hint: Spongocoel is lined by flagellated cells.

Sol.:

- Fallopian tubes are lined by ciliated columnar epithelium. Ciliary movement helps in passage of ovum through oviduct.
- Flagellar movement helps in maintenance of water current in the canal system of sponges.
- Macrophages and leucocytes exhibit amoeboid movement.
- Movement of our limbs, jaws, tongue, etc, require muscular movement.

154. Answer (2)

Hint: Striations are absent

Sol.: Muscles have been classified using different criteria, namely location, appearance and nature of regulation of their activities.

Parameter	Types of muscles		
Location	Skeletal	Visceral	Cardiac
Appearance	Striated	Non-striated	Striated
Nature of regulation	Voluntary	Involuntary	Involuntary

155. Answer (3)

Hint: Muscle fibres are in polarised state during resting condition.

Sol.:

- Muscles are mesodermal in origin.
- Muscles constitute 40-50% of the body weight in an adult human.
- Skeletal muscles (voluntary striated muscles) are primarily involved in locomotory actions and change of body postures and not in all movements.
- Muscle fibres show excitability, conductivity, extensibility, elasticity and contractility.

156. Answer (3)

Hint: Endoplasmic reticulum

Sol.:

- Sarcoplasmic reticulum (endoplasmic reticulum) is the store house of calcium ions.
- Plasma membrane of muscle fibre is called sarcolemma.
- Cytoplasm of muscle fibre is called sarcoplasm.
- In involuntary muscles, ECF is the main source of calcium ions.

157. Answer (4)

Hint: 'Z' line is elastic

Sol.:

- 'Z' line is an elastic fibre which bisects 'I' band containing actin filaments.
- 'M' line is a thin fibrous membrane.
- Sarcomere is the portion of myofibrils between two successive 'Z' lines.

158. Answer (2)

Hint: 'H'-zone

Sol.: Length of I-band, H-zone and sarcomere decreases during muscle contraction while length of A-band remains same.

159. Answer (1)

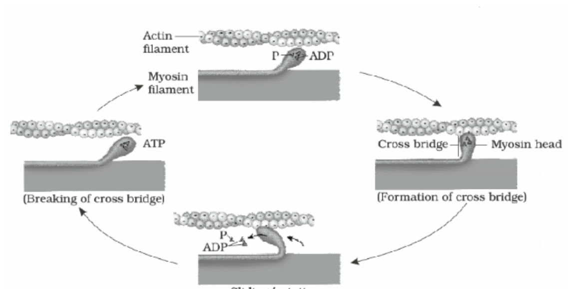
Hint: Function of troponin

Sol.: In the resting state of skeletal muscle fibre, a subunit of troponin (troponin-I) along with tropomyosin masks the active binding sites for myosin on the actin filaments.

160. Answer (2)

Hint: Cross bridge formation requires energy

Sol.:



161. Answer (3)

Hint: Storehouse of calcium ions in skeletal muscle fibres

Sol.: Myoglobin content, number of mitochondria and amount of stored oxygen is high in red muscle fibres as compared to white muscle fibres but amount of sarcoplasmic reticulum is high in white muscle fibres.

162. Answer (4)

Hint: Length of A-band remains same during muscle contraction.

Sol.: Actin and myosin filaments do not shorten during muscle contraction.

Contraction of a muscle fibre takes place by the sliding of the thin filaments over the thick filaments.

163. Answer (3)

Hint: Example of freely movable joint

Sol.:

- In fibrous joints (e.g., sutures of skull), bones are fused with the help of dense fibrous connective tissues.
- In cartilaginous joints (e.g., pubic symphysis), the bones involved are joined together with the help of cartilages.
- In synovial joints (e.g., carpo-metacarpal joint, gliding joint, etc.), synovial fluid is present between articulating surfaces of the two bones.

164. Answer (4)

Hint: Hyoid bone

Sol.: Human skull is dicondylic. Atlas (first vertebra) articulates with two occipital condyles. Only parietal and temporal bones are paired cranial bones.

165. Answer (1)

Hint: Number of cervical vertebrae in sloth

Sol.: Almost all mammals including human beings have seven cervical vertebrae. Other characteristic features of mammals are:

- Presence of mammary glands.
- Presence of pinna, hair on body, sweat glands and a four-chambered heart.

166. Answer (2)

Hint: Phalangeal formula for hands is 2,3,3,3,3

Sol.: In digits of one forelimb, 14 phalanges are present. So, in both the forelimbs 28 bones are present.

167. Answer (3)

Hint: Medial surface is closer to central axis of the body.

Sol.:

- Glenoid cavity is present below acromion process.
- Patella covers the knee ventrally.
- Fibula is present on the lateral aspect of hind limb.
- One end of clavicle articulates with acromion process of scapula and another end articulates with sternum.

168. Answer (4)

Hint: Joint present in hand

Sol.: Saddle joint is present between carpal and metacarpal of thumb side. Gliding joint is present between the carpals as well as between the tarsals. Hinge joint is present between femur and tibia forming knee joint. Ball and socket joint is present between humerus and glenoid cavity of pectoral girdle forming shoulder joint.

169. Answer (2)

Hint: Muscular dystrophy is a genetic disorder.

Sol.:

- In myasthenia gravis, antibodies act against receptors present on sarcolemma for acetylcholine.
- Muscular dystrophy is a genetic disorder characterised by progressive degeneration of skeletal muscle.
- Tetany is due to low calcium in body fluids.
- Osteoporosis is an age-related disorder characterised by decreased bone mass.

170. Answer (1)

Hint: Less glomerular blood pressure

Sol.: The JGA plays a complex regulatory role. A fall in glomerular blood pressure can activate the JG cells to release renin which converts angiotensinogen in blood to angiotensin-I. ACE converts angiotensin-I to angiotensin-II. Angiotensin-II increases glomerular blood pressure.

171. Answer (2)

Hint: Part of nephron where maximum re-absorption takes place

Sol.: Nearly all of essential nutrients, and 70-80% of water are reabsorbed by PCT. The composition of glomerular filtrate is almost same as that of plasma except the proteins which are not present in glomerular filtrate.

ADH deficiency leads to polyuria.

172. Answer (2)

Hint: Present in inner wall of Bowman's capsule

Sol.: Podocytes create minute spaces for the filtration of blood into the Bowman's space.

Efferent arteriole carries blood away from glomerulus and maximum reabsorption of amino acids occurs in PCT.

173. Answer (4)

Hint: Double walled cup like structure

Sol.: PCT, DCT and collecting duct are responsible for the maintenance of ions and pH of blood. They do so by selective secretion and reabsorption.

174. Answer (4)

Hint: High blood pressure stimulates its secretion

Sol.: ANF causes vasodilation, decrease blood pressure and opposes the regulation by RAAS. Angiotensin II is a vasoconstrictor and thereby increases the blood pressure.

175. Answer (2)

Hint: Lizards are uricotelic

Sol.:

Bony fishes	–	Ammonotelic
Land snails and reptiles	–	Uricotelic
Land amphibians	–	Ureotelic
Urea formation	–	Liver

176. Answer (3)

Hint: Structure which emerges from glomerulus

Sol.: Efferent arteriole emerges from glomerulus and forms a fine capillary network around the renal tubule called peritubular capillaries. A minute vessel of this network runs parallel to the Henle's loop forming a U-shaped vasa recta.

177. Answer (4)

Hint: About 20 percent of renal plasma flow

Sol.: Net filtration pressure = GHP – (BCOP + CHP)

where, GHP – Glomerular hydrostatic pressure

BCOP – Blood colloidal osmotic pressure

CHP – Capsular hydrostatic pressure

178. Answer (4)

Hint: Not considered as a part of renal tubule

Sol.: Aldosterone acts on DCT and collecting duct, so conditional reabsorption of salt and water takes place under the influence of aldosterone in these parts.

179. Answer (1)

Hint: 1200 mOsmol/L

Sol.: Human kidneys normally produce urine about four times more concentrated than the initial filtrate formed.

180. Answer (2)

Hint: Associated with uricotelism

Sol.: Sweat produced by sweat glands is a watery fluid which contains NaCl, small amount of urea, amino acids and glucose, etc.

181. Answer (3)

Hint: Hyperglycemia

Sol.: Presence of ketone bodies and glucose in urine are associated with diabetes mellitus.

Pyelonephritis – Inflammation in renal pelvis

Glomerulonephritis – Inflammation in glomeruli.

182. Answer (1)

Hint: Part of ANS which works in resting condition

Sol.: Parasympathetic nerve fibres – Constriction of urinary bladder and relaxation of internal urethral sphincter

Sympathetic nerve fibres – Dilation of urinary bladder and constriction of internal urethral sphincter.

183. Answer (2)

Hint: Hyponatremia

Sol.: Aldosterone stimulates the reabsorption of Na^+ and water from DCT and collecting tubule. This leads to an increase in blood volume and blood pressure.

184. Answer (2)

Hint: Width is more than 5 cm

Sol.: The adult human kidney measures:

Length	Width	Weight
10-12 cm	5-7 cm	120-170 gm

185. Answer (2)

Hint: Osmolarity more than 300 mOsmol L^{-1}

Sol.: In descending limb of loop of Henle, the osmolarity of filtrate changes from 300 mOsmol L^{-1} to 1200 mOsmol L^{-1}.

SECTION - B

186. Answer (2)

Hint: Equal to the number of palm bones in one fore limb

Sol.: The skull, vertebral column, sternum and ribs constitute axial skeleton. Hyoid, lacrimal, zygomatic and incus are skull bones. Axis is second vertebra. Scapula, carpals and ilium are bones of appendicular skeleton.

187. Answer (4)

Hint: Vertebrosternal ribs are true ribs.

Sol.:

- First seven pairs of ribs are true ribs (vertebrosternal ribs). Dorsally, they are attached to the thoracic vertebrae and ventrally connected to sternum with the help of hyaline cartilage.

- The 8th, 9th and 10th pairs of ribs do not articulate directly with the sternum but join the seventh rib with the help of hyaline cartilage. These are called vertebrochondral ribs (false ribs).
- Last 2 pairs (11th and 12th) of ribs are not connected ventrally and are therefore, called floating ribs or vertebral ribs.

188. Answer (4)

Hint: Foramen magnum is present at the base of skull.

Sol.: Base of the skull has a large opening called foramen magnum through which the brain communicates with the spinal cord.

Spinal cord is present in neural canal of vertebral column.

189. Answer (2)

Hint: Articular cartilage

Sol.: At the ends of long bones, hyaline cartilage is present. Matrix of cartilage is slightly pliable while that of bone is non-pliable.

190. Answer (2)

Hint: Acetylcholine receptors are present on sarcolemma.

Sol.: Muscle contraction is initiated by a signal sent by the CNS via a motor neuron.

A neural signal reaching to neuromuscular junction releases acetylcholine. Acetylcholine binds with its receptors present on sarcolemma. As a result, action potential generates in the sarcolemma.

191. Answer (4)

Hint: Ileum is a part of small intestine

Sol.:
- Ossein protein is present in matrix of bones.
- Myosin is a contractile protein.
- Ilium, ischium and pubis fuse to form coxal bone. Ileum is the longest part of small intestine.

192. Answer (1)

Hint: Relaxation of urethral sphincter

Sol.: During micturition, the CNS passes on motor messages to initiate the contraction of smooth muscles of the bladder and simultaneous relaxation of the urethral sphincter causing the release of urine.

193. Answer (4)

Hint: Less than 300 mL/minute

Sol.: Our lungs remove large amounts of CO_2 approximately 200 mL/ minute or 12000 mL/hour.

194. Answer (2)

Hint: 20% of cardiac output is filtered per minute

Sol.: About 1100 - 1200 mL of blood is filtred by the kidneys per minute which constitutes roughly 1/5th of the blood pumped out by each ventricle of the heart in a minute.

The amount of the filtrate formed by the kidneys per minute is called glomerular filtration rate (GFR). GFR in a healthy individual is about 125 mL/min.

195. Answer (3)

Hint: Land insects

Sol.: Cat – Ureotelism

Salamander – Ammonotelism

Cockroach – Uricotelism

Earthworm – Ammonotelic in water and ureotelic in moist soil.

196. Answer (4)

Hint: Short loop of Henle

Sol.: In juxtamedullary nephrons, the loop of Henle is long as compared to cortical nephrons and they possess vasa recta which is absent in cortical nephrons.

197. Answer (2)

Hint: Possess filtration slits

Sol.: The epithelial cells of Bowman's capsule called podocytes are arranged in an intricate manner so as to leave some minute spaces called slit pores or filtration slits.

198. Answer (3)

Hint: Exhibit osmolarity 200 $mOsmL^{-1}$.

Sol.: Conditional reabsorption of water occurs under the influence of ADH in DCT and collecting duct. Collecting duct is not included in renal tubule.

199. Answer (3)

Hint: Low threshold value substance.

Sol.: Nitrogenous wastes like urea are reabsorbed passively from renal tubule whereas glucose and ions like Na^+ are reabsorbed actively.

200. Answer (2)

Hint: Insoluble mass of crystallised salts

Sol.: In renal calculi, stone or insoluble mass of crystallised salts (oxalates, etc) are formed within the kidney

❑ ❑ ❑

All India Aakash Test Series for NEET-2023

TEST - 4 (Code-D)

Test Date : 20/02/2022

ANSWERS

1. (2)	41. (2)	81. (3)	121. (4)	161. (2)
2. (4)	42. (4)	82. (4)	122. (4)	162. (4)
3. (2)	43. (1)	83. (2)	123. (2)	163. (4)
4. (1)	44. (4)	84. (4)	124. (4)	164. (2)
5. (2)	45. (3)	85. (2)	125. (1)	165. (2)
6. (3)	46. (2)	86. (4)	126. (3)	166. (1)
7. (2)	47. (4)	87. (2)	127. (4)	167. (2)
8. (4)	48. (4)	88. (2)	128. (1)	168. (4)
9. (3)	49. (3)	89. (3)	129. (3)	169. (3)
10. (3)	50. (3)	90. (1)	130. (1)	170. (2)
11. (3)	51. (2)	91. (3)	131. (4)	171. (1)
12. (1)	52. (1)	92. (2)	132. (1)	172. (4)
13. (2)	53. (3)	93. (1)	133. (3)	173. (3)
14. (4)	54. (4)	94. (1)	134. (3)	174. (4)
15. (4)	55. (2)	95. (3)	135. (2)	175. (3)
16. (3)	56. (1)	96. (2)	136. (1)	176. (2)
17. (4)	57. (2)	97. (3)	137. (2)	177. (1)
18. (1)	58. (3)	98. (2)	138. (1)	178. (2)
19. (4)	59. (3)	99. (4)	139. (4)	179. (4)
20. (3)	60. (4)	100. (2)	140. (2)	180. (3)
21. (1)	61. (3)	101. (4)	141. (2)	181. (3)
22. (3)	62. (1)	102. (2)	142. (3)	182. (2)
23. (1)	63. (2)	103. (1)	143. (1)	183. (3)
24. (3)	64. (3)	104. (2)	144. (3)	184. (2)
25. (2)	65. (2)	105. (3)	145. (3)	185. (2)
26. (3)	66. (2)	106. (1)	146. (2)	186. (2)
27. (4)	67. (2)	107. (1)	147. (4)	187. (3)
28. (2)	68. (2)	108. (1)	148. (1)	188. (3)
29. (2)	69. (3)	109. (2)	149. (3)	189. (2)
30. (4)	70. (2)	110. (4)	150. (1)	190. (4)
31. (3)	71. (1)	111. (3)	151. (2)	191. (3)
32. (2)	72. (4)	112. (4)	152. (2)	192. (2)
33. (4)	73. (3)	113. (1)	153. (2)	193. (4)
34. (3)	74. (3)	114. (4)	154. (1)	194. (1)
35. (1)	75. (4)	115. (4)	155. (3)	195. (4)
36. (2)	76. (1)	116. (2)	156. (2)	196. (2)
37. (3)	77. (3)	117. (4)	157. (1)	197. (2)
38. (4)	78. (1)	118. (3)	158. (4)	198. (4)
39. (3)	79. (4)	119. (2)	159. (4)	199. (4)
40. (1)	80. (3)	120. (2)	160. (3)	200. (2)

HINTS & SOLUTIONS

[PHYSICS]

SECTION - A

1. Answer (2)

Hint: Kinetic energy of body performing rolling motion is $\frac{1}{2}mv^2\left(1+\frac{k^2}{R^2}\right)$

Sol.: Kinetic energy $=\frac{1}{2}mv^2\left(1+\frac{k^2}{R^2}\right)$

$\Rightarrow \frac{1}{2}\times 10\times 4\left(1+\frac{2}{5}\right)=28$ J

2. Answer (4)

Hint: In sudden compression, angular momentum of rigid body will be conserved.

Sol.: By using conservation of angular momentum

$I_1\omega_1 = I_2\omega_2$

$\Rightarrow \frac{2}{5}MR^2\times\frac{2\pi}{T}=\frac{2}{5}M\times\frac{R^2}{16}\times\frac{2\pi}{T'}$

$\Rightarrow T'=\frac{T}{16}=\frac{24}{16}=\frac{3}{2}$ hours

3. Answer (2)

Hint: On applying couple, net force on rigid body will be zero.

Sol.:

Net force on rod is zero but net torque is non-zero. So rod will perform rotational motion.

4. Answer (1)

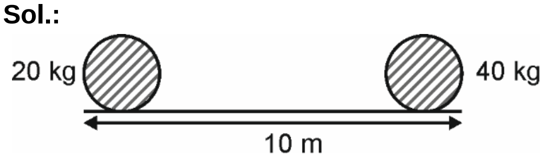
Hint: Use law of conservation of angular momentum principle.

Sol.: On folding his arms, moment of inertia decreases. So angular velocity increases.

5. Answer (2)

Hint: Centre of mass of system remains at same position if the net external force is zero.

Sol.:



$20x = 40\ (10 - x)$

$\Rightarrow\ 20x = 400 - 40x$

$\Rightarrow\ 60x = 400$

$\Rightarrow\ x = 6.67$ m

6. Answer (3)

Hint: Torque acting on rigid body (τ) = Iα

Sol.: $mg - T = ma$ … (1)

$T.R=\frac{mR^2}{2}\times\frac{a}{R}$ … (2)

Solving equation (1) and (2)

$\Rightarrow\ a=\frac{2g}{3}$

7. Answer (2)

Hint: Kinetic energy of a rigid body performing rolling motion is $\frac{1}{2}mv^2\left(1+\frac{k^2}{R^2}\right)$

Sol.: $K_T=\frac{1}{2}mv^2$

$K_R=\frac{1}{2}I\omega^2=\frac{1}{2}Mk^2\left(\frac{v^2}{R^2}\right)$

$\Rightarrow\ \frac{K_{\text{Rotational}}}{K_{\text{Rolling}}}=\frac{\frac{1}{2}Mv^2\left(\frac{k^2}{R^2}\right)}{\frac{1}{2}Mv^2\left(1+\frac{k^2}{R^2}\right)}=\frac{k^2}{R^2+k^2}$

For hollow sphere, $k=\sqrt{\frac{2}{3}}R$

$\Rightarrow\ \frac{K_{\text{Rotational}}}{K_{\text{Rolling}}}=\frac{2}{5}$

8. Answer (4)

Hint: Torque on rigid body (τ) = $I\alpha$

Sol.: Torque (τ) = $I\alpha$ = $I\left(\frac{d\omega}{dt}\right)$

$\Rightarrow\ \theta=3t^3-4t^2$

$\Rightarrow\ \omega=9t^2-8t$

$\Rightarrow\ \alpha=18t-8$

When $\alpha = 0$; $\tau = 0$

$\Rightarrow\ t=\frac{8}{18}=\frac{4}{9}$ s

9. Answer (3)

Hint: $a = \dfrac{g\sin\theta}{1+\dfrac{k^2}{R^2}}$ and $S = ut + \dfrac{1}{2}at^2$

Sol.: For solid cylinder, $\dfrac{k^2}{R^2} = \dfrac{1}{2}$

$$a = \frac{g\sin\theta}{1+\frac{1}{2}}$$

$$a = \frac{2g\sin\theta}{3}$$

$$S = ut + \frac{1}{2}at^2$$

$$l = \frac{1}{2}\left(\frac{2g\sin\theta}{3}\right)t^2$$

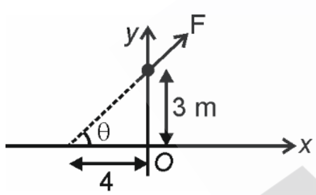
$$t = \sqrt{\frac{3l}{g\sin\theta}}$$

10. Answer (3)

Hint:

Angular momentum of particle (L) = $mvr\sin\theta(\hat{n})$

Sol.:



$$L = mvr\sin\theta(\hat{n})$$

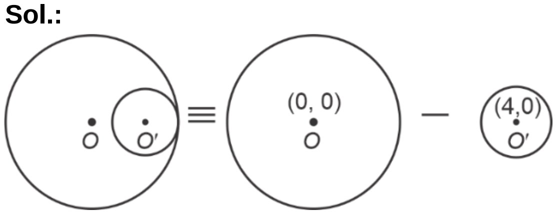
$$L_A = mva(-\hat{k})$$

$$L_B = mva(-\hat{k})$$

11. Answer (3)

Hint: For cutting of a body (r_{CM}) = $\dfrac{m_1r_1 - m_2r_2}{m_1 - m_2}$

Sol.:



Mass of complete disc (M_1) = $\rho\pi(6)^2 = m$

Mass of hole (M_2) = $\rho\pi(2)^2 = \dfrac{m}{9}$

$$r_{CM} = \frac{m(0) - \frac{m}{9}(4)}{m - \frac{m}{9}} = -\frac{1}{2}\text{ cm}$$

12. Answer (1)

Hint: Acceleration due to gravity $(g) = \dfrac{GM}{R^2}$

Sol.: $g_1 = \dfrac{GM_1}{R_1^2}$ and $g_2 = \dfrac{GM_2}{R_2^2}$

$$g_1 = \frac{G\times\rho_1\times\frac{4}{3}\pi R_1^3}{R_1^2} = \frac{4}{3}\pi G\rho_1R_1$$

$$\frac{g_1}{g_2} = \frac{\rho_1R_1}{\rho_2R_2} = \frac{1}{2}\times\frac{4}{1} = \frac{2}{1}$$

13. Answer (2)

Hint: Use energy conservation principle

Sol.: $U_i + K_i = U_f + K_f$

$$-\frac{GMm}{4R} + \frac{1}{2}mv^2 = 0 + 0$$

$\Rightarrow$ Energy = $+\dfrac{GMm}{4R} = +\dfrac{mgR}{4}$

14. Answer (4)

Hint: For equilibrium of a rigid body, resultant torque and force should be zero.

Sol.: Torque due to force (τ) = $rF\sin\theta$

Net torque on rod

$$(\vec{\tau}) = 20F(\hat{k}) + 120F(-\hat{k}) + 180F(\hat{k}) + 80F(-\hat{k})$$

$\Rightarrow \tau_{net} = 0$

So rod remains at rest.

15. Answer (4)

Hint: Use conservation of angular momentum.

Sol.: $I_1\omega_1 = I_2\omega_2$

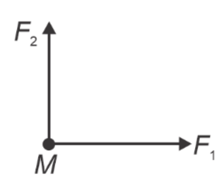
$$\frac{2}{5}MR^2\omega = \frac{2}{5}M\left(\frac{R}{2}\right)^2\omega'$$

$\Rightarrow$ $\omega' = 4\omega$

16. Answer (3)

Hint: Use $\vec{F} = -\dfrac{Gm_1m_2}{r^2}\hat{r}$

Sol.:



$$\vec{F}_1 = \frac{GM^2}{(3r)^2}\hat{i}$$

$$\vec{F}_2 = \frac{GM^2}{(4r)^2}\hat{j}$$

$$\vec{F} = \frac{GM^2}{r^2}\left(\frac{1}{9}\hat{i} + \frac{1}{16}\hat{j}\right)$$

17. Answer (4)

Hint: Use result of gravity inside and outside the surface of earth.

Sol.:

$0 \le r < R \quad \Rightarrow \quad E = \frac{GMr}{R^3}$

$r = R \quad \Rightarrow \quad E = \frac{GM}{R^2}$

$r > R \quad \Rightarrow \quad E = \frac{GM}{r^2}$

18. Answer (1)

Hint & Sol.: Here net external force on system = 0.

So, v_{CM} = constant = 0

19. Answer (4)

Hint: Use $\vec{v}_{CM} = \frac{m_1\vec{v}_1 + m_2\vec{v}_2}{m_1 + m_2}$

Sol.: Velocity of centre of mass

$$\vec{v}_{CM} = \frac{m_1\vec{v}_1 + m_2\vec{v}_2}{m_1 + m_2} = \frac{4\times 5\hat{i} + 6\times 10\hat{j}}{4+6}$$

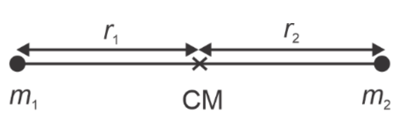
$$\vec{v}_{CM} = \frac{20\hat{i} + 60\hat{j}}{10} = 2\hat{i} + 6\hat{j}$$

$$|\vec{v}_{CM}| = \sqrt{40} \text{ m/s}$$

20. Answer (3)

Hint: For two point mass system: $m_1 r_1 = m_2 r_2$

Sol.:



$\Rightarrow \quad m_1 r_1 = m_2 r_2$

$\Rightarrow \quad \frac{m_1}{m_2} = \frac{r_2}{r_1}$

21. Answer (1)

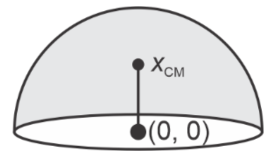
Hint: Use $\vec{v} = \vec{\omega} \times \vec{r}$

Sol.: $\vec{v} = \vec{\omega} \times \vec{r} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 1 & -2 & 1 \\ 2 & 3 & 1 \end{vmatrix} = -5\hat{i} + \hat{j} + 7\hat{k}$

22. Answer (3)

Hint: Use position of centre of mass for a hollow hemisphere from base $\left(0, \frac{R}{2}\right)$.

Sol.:



Position of centre of mass = $\left(0, \frac{R}{2}\right) = (0, 10)$ cm

23. Answer (1)

Hint: Acceleration due to gravity $(g) = \frac{GM}{R^2}$

Sol.: $g = -\frac{GM}{R^2} \Rightarrow \frac{\Delta g}{g} = -\frac{2\Delta R}{R}$

$\frac{\Delta g}{g} \times 100 = -2(-2\%)$

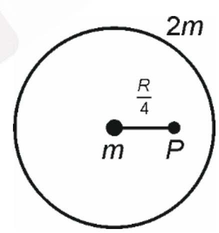
$= 4\%$

24. Answer (3)

Hint: Gravitational potential for spherical shell

$= -\frac{Gm}{R}(0 < r < R)$

Sol.:



$$V_P = -\frac{Gm}{R/4} - \frac{G(2m)}{R}$$

$$V_P = -\frac{6Gm}{R}$$

25. Answer (2)

Hint: Use $g' = \frac{gR^2}{(R+h)^2}$

Sol.: $g' = \frac{gR^2}{(R+h)^2}$

$\Rightarrow \quad g' = \frac{gR^2}{4R^2} = \frac{g}{4} \quad (\because h = R)$

$\Rightarrow \quad W' = mg' = \frac{mg}{4} = \frac{80}{4} = 20$ N

26. Answer (3)

Hint: Use $g' = \dfrac{g}{\left(1+\dfrac{h}{R}\right)^2}$

Sol.: $g' = \dfrac{gR^2}{(R+h)^2}$

$\Rightarrow \quad \dfrac{g}{2} = \dfrac{gR^2}{(R+h)^2}$

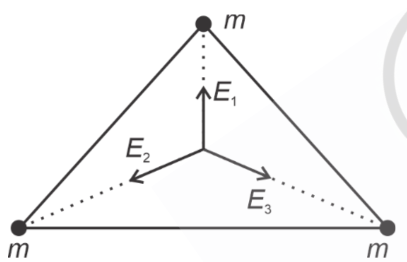
$\Rightarrow \quad R+h = \sqrt{2}R$

$\Rightarrow \quad h = (\sqrt{2}-1)R$

27. Answer (4)

Hint: Use $\vec{E} = -\dfrac{GM\vec{r}}{r^3}$

Sol.:



$\vec{E}_{\text{net}} = \vec{E}_1 + \vec{E}_2 + \vec{E}_3 = 0$

28. Answer (2)

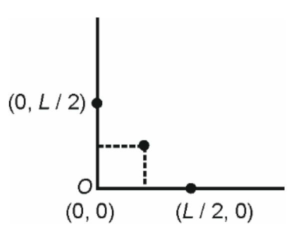
Hint: Use law of conservation of angular momentum.

Sol.: At point *B*, distance is minimum, hence velocity is maximum using law of conservation of angular momentum.

29. Answer (2)

Hint: For symmetric body having uniform mass distribution, centre of mass lies at line of symmetry.

Sol.:



$$x_{\text{CM}} = \frac{M\times\frac{L}{2} + M\times 0}{M+M} = \frac{L}{4}$$

$$y_{\text{CM}} = \frac{M\times 0 + M\times\frac{L}{2}}{M+M} = \frac{L}{4}$$

Distance (r) = $\sqrt{\left(\dfrac{L}{4}-0\right)^2 + \left(\dfrac{L}{4}-0\right)^2} = \dfrac{L}{2\sqrt{2}}$

30. Answer (4)

Hint: $x_{\text{CM}} = \dfrac{m_1x_1 + m_2x_2 + m_3x_3}{m_1+m_2+m_3}$

Sol.: $x_{\text{CM}} = \dfrac{M\times R + M\times 3R + M\times 5R}{3M} = \dfrac{9MR}{3M}$

$x_{\text{CM}} = 3R;\ y_{\text{CM}} = 0$

31. Answer (3)

Hint: Use work done $(W)_{\text{ext}} = \Delta U$

Sol.: $U_i = -\dfrac{GMm}{2R_e}$

$U_f = -\dfrac{GMm}{4R_e}$

$\Rightarrow \quad \Delta U = -\dfrac{GMm}{4R_e} - \left(-\dfrac{GMm}{2R_e}\right) = \dfrac{GMm}{4R_e}$

32. Answer (2)

Hint: Use torque (τ) = $I\alpha$

Sol.: $\alpha = \dfrac{\Delta\omega}{\Delta t}$

$\Rightarrow \quad \tau = \dfrac{I\Delta\omega}{\Delta t} = \dfrac{4\times 10^2\times 8}{2}$

$\Rightarrow \quad \tau = 16\times 10^2$ = 1.6×10^3 N m

33. Answer (4)

Hint: Moment of inertia of a rod about an axis passing through its end = $\dfrac{Ml^2}{3}$

Sol.: MI of rod about its end = $\dfrac{Ml^2}{3}$

$\Rightarrow \quad I = \dfrac{300\times 10^{-3}\times 400\times 10^{-4}}{3}$

$\Rightarrow \quad I = 4\times 10^{-3}$ kg m^2

34. Answer (3)

Hint: Use parallel and perpendicular axis theorems.

Sol.: Given, $I = \frac{MR^2}{4} + MR^2 = \frac{5}{4}MR^2$

Now, $I' = \frac{MR^2}{2} + MR^2 = \frac{3}{2}MR^2$

$\Rightarrow \quad I' = \frac{3}{2} \times \frac{4I}{5} = \frac{6I}{5}$

35. Answer (1)

Hint: Moment of inertia of ring about centre of mass and perpendicular to plane = MR^2

Sol.: Moment of inertia = Mk^2,

where k is radius of gyration

$\Rightarrow \quad Mk^2 = MR^2$

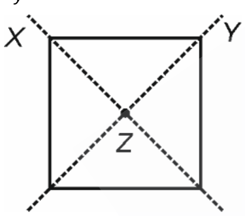
$\Rightarrow \quad k = R$

SECTION - B

36. Answer (2)

Hint: Diagonals of square intersect each other at right angle.

Sol.: $I_z = I_x + I_y$



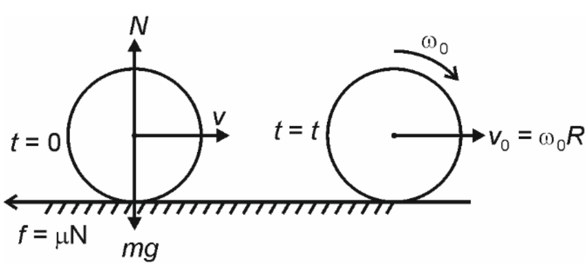
$\frac{ma^2}{6} = 2I_y \quad (\because \; I_x = I_y)$

$\Rightarrow \quad I_y = \frac{ma^2}{12}$

37. Answer (3)

Hint: Disc will perform rolling with forward slipping initially

Sol.:



$f = \mu N = ma$

$\Rightarrow \quad a = \mu g$, retardation

So, $v_0 = v - at$

$\Rightarrow \quad v_0 = v - \mu gt$

Now $\quad \tau = I\alpha$

$\Rightarrow \quad \mu NR = \frac{MR^2}{2}\alpha$

$\Rightarrow \quad \alpha = \frac{2\mu g}{R}$

So, $\quad \Rightarrow \omega_0 = \alpha t$

$\Rightarrow \quad \frac{v_0}{R} = \frac{2\mu gt}{R}$

$\Rightarrow \quad v - \mu gt = 2\mu gt$

$\Rightarrow \quad t = \frac{v}{3\mu g}$

38. Answer (4)

Hint: $\vec{a}_{cm} = \frac{m_1\vec{a}_1 + m_2\vec{a}_2}{m_1 + m_2}$

Sol.: As $a = \left(\frac{m_1 - m_2}{m_1 + m_2}\right)g = \frac{4-2}{4+2} \times 10 = \frac{10}{3}$ m/s^2

$$\vec{a}_{cm} = \frac{2 \times \left(\frac{10}{3}\hat{j}\right) + 4\left(-\frac{10}{3}\hat{j}\right)}{2+4} = \frac{\frac{20}{3}\hat{j} - \frac{40}{3}\hat{j}}{6}$$

$= \left(-\frac{10}{9}\hat{j}\right)$ m/s^2

39. Answer (3)

Hint & Sol.: $v > \sqrt{2}\, v_{orbital}$, so satellite will escape with hyperbolic path.

40. Answer (1)

Hint: Use escape velocity $v_e = \sqrt{\frac{2GM}{R}}$ and $U = \frac{-GMm}{R}$

Sol.: $v_e = \sqrt{\frac{2GM}{R}} = 50$ m s^{-1}

$\Rightarrow \quad \frac{2GM}{R} = 2500$

$\Rightarrow U = \frac{-GMm}{R} = -\frac{2500 \times 1}{2} = -1250$ J

41. Answer (2)

Hint: Use time period of satellite $T^2 \propto r^3$

Sol.: Time period of satellite $(T) = 2\pi\sqrt{\frac{r^3}{GM}}$

Potential energy of satellite $(U) = \frac{-GMm}{r}$

$\Rightarrow \quad T^2 \propto r^3 \propto \frac{1}{U^3}$

42. Answer (4)

Hint: Use time period of simple pendulum $(T) = 2\pi\sqrt{\frac{l}{g}}$

Sol.: In orbiting satellite; $g_{\text{eff}} = 0$

So, $T = 2\pi\sqrt{\frac{l}{0}} = \infty$

43. Answer (1)

Hint: Use energy conservation principle

Sol.: $U_i + K_i = U_f + K_f$

$$\frac{-GMm}{R} + \frac{1}{2}mv_e^2 = 0 + 0$$

$$\Rightarrow v_e = \sqrt{\frac{2GM}{R}}$$

(independent of angle of projection)

44. Answer (4)

Hint: Use orbital velocity of satellite $(v_o) = \sqrt{\frac{GM}{r}}$

Sol.: $\frac{v_{o_1}}{v_{o_2}} = \sqrt{\frac{r_2}{r_1}} = \sqrt{\frac{2}{3}} \Rightarrow v_{o_1} = \sqrt{\frac{2}{3}}v$

45. Answer (3)

Hint: Use power (P) = $\vec{\tau}.\vec{\omega}$

Sol.: Power of rotating body (P) = $\tau\omega$

$$\Rightarrow \tau = \frac{P}{\omega} = \frac{50}{4} = 12.5 \text{ N m}$$

46. Answer (2)

Hint: Torque on rigid body (τ) = $I\alpha$

Sol.: Torque on rigid body (τ) = 100 = 20 α

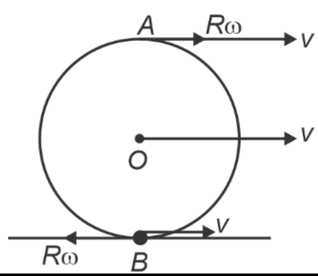
$$\Rightarrow \alpha = 5 = \frac{\Delta\omega}{\Delta t}$$

$\omega = \omega_0 + \alpha t$

$\Rightarrow \omega = 0 + 5 \times 4 = 20$ rad/s

47. Answer (4)

Hint & Sol.:



$v_A = v + R\omega = 2v$

$v_B = v - R\omega = 0$

$v_A - v_B = 2v$

48. Answer (4)

Hint: Gravitational potential $V = \frac{-GM}{r}$

Gravitational potential energy, $U = \frac{-GMm}{r}$

Sol.:

A. Gravitational potential, at centre O,

$$V = \frac{-4GM}{r}$$

$$= \frac{-4 \times G \times 2}{\frac{1}{\sqrt{2}}} = -8\sqrt{2}G$$

B. Gravitational potential energy of system.

$$U = \frac{-2GM^2}{(\sqrt{2})} - 4\frac{GM^2}{1}$$

$$= -4\sqrt{2}G - 16G$$

$$= -4(4 + \sqrt{2})G$$

C. net gravitational field at centre O is zero

D. Force on mass at point A

$$|\vec{F}_A| = \frac{\sqrt{2}GM^2}{1^2} + \frac{GM^2}{(\sqrt{2})^2}$$

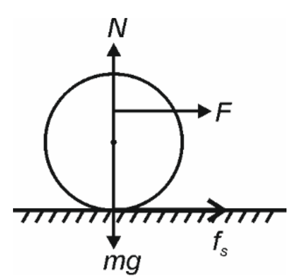
$$= 4\sqrt{2}G + 2G$$

$$= (4\sqrt{2} + 2)G$$

49. Answer (3)

Hint: For pure rolling $a_{\text{com}} = R\alpha$

Sol.:



$F + f_s = ma$ ...I

$$F\frac{R}{2} - f_s.R = I\alpha$$

$$\Rightarrow \frac{F}{2} - f_s = \frac{Ia}{R^2} \quad \text{...II}$$

on solving (I) and (II)

$$a = \frac{15}{14}\frac{F}{m} \text{ and } f_s = \frac{F}{14}$$

Now $f_s \le f_{s\,max}$

$$\Rightarrow \frac{F}{14} \le \mu mg$$

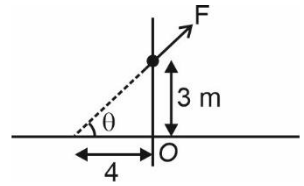
$$\Rightarrow \mu \ge \frac{F}{14mg}$$

$$\mu_{min} = \frac{F}{14mg} = \frac{7mg}{14mg} = \frac{1}{2}$$

50. Answer (3)

Hint: Torque on the body $(\vec{\tau}) = rF\sin\theta(\hat{n})$

Sol.:



Torque about origin (τ) = $rF\sin\theta$

$\Rightarrow \quad \tau = 3 \times 10 \times \sin(90° - \theta)$

$\Rightarrow \quad \tau = 3 \times 10 \times \frac{4}{5} = 24$ Nm

[CHEMISTRY]

SECTION - A

51. Answer (2)

Hint: ΔH_{rxn} = $\sum$BE (Reactant) – $\sum$BE (Product)

Sol.: $\frac{1}{2}A_2 + \frac{1}{2}B_2 \longrightarrow AB$

$\Delta H_{rxn} = \frac{1}{2}(2x) + \frac{1}{2}(1.5x) - 2x$

= x + 0.75x – 2x = – 0.25x = – 300

So, x = 1200

Hence, bond dissociation energy of B_2

= 1.5 × 1200 = 1800 kJ mol^{-1}

52. Answer (1)

Hint: ΔH_C (H_2(g)) = $\Delta_f H$ (H_2O(l))

Sol.:

- No. of moles in 3.6 g of H_2O(l) = $\frac{3.6}{18}$ = 0.2 mol
- So, heat released for formation of 0.2 mol H_2O(l) = 0.2 × (–285.8) = –57.16 kJ

53. Answer (3)

Hint: CH_4(g) has four 'C – H' bonds.

Sol.: For $CH_4(g) \longrightarrow C(g) + 4H(g)$

ΔH_r = 4BE(C – H)

$\therefore \ BE(C-H) = \frac{\Delta H_r}{4} = \frac{1665}{4}$ = 416.25 kJ mol^{-1}

54. Answer (4)

Hint: For all gases, ratio of $\frac{C_p}{C_v}$ is independent of R.

Sol.: For monoatomic gas, $\frac{C_p}{C_v} = \frac{5}{3}$

55. Answer (2)

Hint: For irreversible expansion,

W = – P_{ext} (V_f – V_i)

Sol.: W = – 2 atm (20 – 10) L

= –2 × 10 L - atm

= –20 L - atm

56. Answer (1)

Hint: Entropy order: Solid < Liquid < Gas

Sol.:

- Melting of gallium results in increase of entropy.
- Dimerisation of benzoic acid, liquifaction of N_2(g) and formation of NH_3 by using N_2(g) and H_2(g) have $\Delta S < 0$.

57. Answer (2)

Hint: Standard state of O_2 is gas.

Sol.: Elements present in standard state have its enthalpy of formation as zero

So, $\Delta_f H°(O_2(l)) \ne 0$

58. Answer (3)

Hint and Sol.: Enthalpy change during conversion of 1 mole species into gaseous atom is equal to enthalpy of atomisation.

59. Answer (3)

Hint: Molar heat capacity = $\frac{1}{n}\frac{dQ}{dT}$

Sol.: For isothermal process, dT = 0

So, molar heat capacity will be infinite.

60. Answer (4)

Hint: $\Delta G = \Delta H - T\Delta S$

The reaction will be spontaneous, if $\Delta G < 0$

Sol.: If $\Delta H < 0$ and $\Delta S > 0$, then $\Delta G < 0$ at all temperatures.

61. Answer (3)

Hint: G = H – TS

Sol.: G is a state function and state functions depend only on the state of the system not how it is reached.

62. Answer (1)

Hint: Molar properties are intensive in nature.

Sol.: Resistance is an extensive property.

63. Answer (2)

Hint: For a gas: $U_{mps} < U_{avg} < U_{rms}$

Sol.:

- Boyle's temperature depends on the nature of gas.
- Area under the Maxwell curve is equal to unity which is independent of the nature of gas.
- Minimum pressure required for liquifaction of gas at critical temperature is known as critical pressure.

64. Answer (3)

Hint: Boyle's temperature $(T_B) = \frac{a}{Rb}$, and

Critical temperature $(T_C) = \frac{8a}{27Rb}$

Sol.: $T_B = \frac{a}{Rb} = 540\text{ K}$

$T_C = \frac{8}{27}\left(\frac{a}{Rb}\right) = \frac{8}{27} \times 540$

= 8 × 20

= 160 K

65. Answer (2)

Hint: Compressibility factor (Z) = $\frac{V_{Real}}{V_{Ideal}}$

Sol.: $\therefore V_{Real} = 1.2\, V_{Ideal}$, $Z = \frac{1.2\, V_{Ideal}}{V_{Ideal}} = 1.2$

Hence, Z > 1 and in this condition repulsive forces are dominant.

66. Answer (2)

Hint: With increase in molar mass, van der Waals forces increases and value of 'a' generally increases.

Sol.: Order of van der Waals constant 'a':

$CO_2 > CH_4 > O_2 > N_2$

Due to more interaction forces CO_2(g) show more negative deviation.

67. Answer (2)

Hint: Root mean square speed (U_{rms}) = $\sqrt{\frac{3RT}{M}}$

Sol.: $U_{rms} = \sqrt{\frac{3 \times 8.314 \times 300}{64 \times 10^{-3}}}$

= 341.9 m/s

$\simeq$ 342 m/s

68. Answer (2)

Hint: PV = nRT

Sol.: PV = nRT

P × 20 L = 0.25 mol × 0.0821 L-atm mol^{-1} K^{-1} × 400 K

($\because$ V = 0.02 m^3 = 20 L)

P = 0.41 atm

69. Answer (3)

Hint: Enthalpy of neutralization of 1 equivalent strong acid with 1 equivalent of strong base is –57.1 kJ.

Sol.: Enthalpy change when 0.5 equivalents of H_2SO_4 and NaOH, neutralization each other is

(ΔH) = – 0.5 × 57.1 kJ

70. Answer (2)

Hint and Sol.: For adiabatic process, q = 0.

71. Answer (1)

Hint: $\Delta_{vap}S = \frac{\Delta_{vap}H}{T_{B.P.}}$

Sol.: $\Delta_{vap}S = \frac{40.66 \times 10^3}{373} = 109\text{ J K}^{-1}\text{ mol}^{-1}$

72. Answer (4)

Hint: Density of an ideal gas $= \frac{PM}{RT}$

Sol.: $d = \frac{PM}{RT} = \frac{2\text{ atm} \times 16\text{ g mol}^{-1}}{0.0821\text{ L-atm K}^{-1}\text{mol}^{-1} \times 600\text{K}}$

= 0.65 g/L

73. Answer (3)

Hint: Greater is the intermolecular forces among molecules, higher is the value of surface tension of liquid.

Sol.:

- Due to presence of more H-bonding, H_2O has highest intermolecular forces and correspondingly highest surface tension.
-

Liquid	Surface tension (dyn cm^{-1}) (At 20°C)
H_2O	72.8
CH_3OH	22.55
CS_2	32.25
C_6H_6	28.87

74. Answer (3)

Hint: Average kinetic energy (for n mole gas) $= \frac{3}{2}nRT$

Sol.: Average kinetic energy for He(g)

$= \frac{3}{2} \times 1 \times R \times 400$

= 600 R

75. Answer (4)

Hint: Pair of non-polar molecules have only dispersion forces.

Sol.: Both Cl_2 and Ne are non-polar molecules, so interact only by dispersion forces.

76. Answer (1)

Hint: Both ionization energy and binding energy terms are used for removal of an electron from an atom.

Sol.: The energy required to increase the surface area of liquid by 1 unit is known as surface energy.

77. Answer (3)

Hint: Stronger the intermolecular forces, higher is the temperature required to maintain a constant vapour pressure.

Sol.: Due to presence of H-bonding in water, it has strongest intermolecular forces, so it requires highest temperature to achieve a given vapour pressure among the given options.

78. Answer (1)

Hint: Force $(F) = \eta A \frac{dv}{dz}$

Sol.: Unit of coefficient of viscosity (η) is $Nm^{-2}s$ or Pa s

79. Answer (4)

Hint: Normal boiling point of water = 100°C

Standard boiling point of water = 99.6°C

Sol.: Difference of normal and standard boiling point of water = 100 – 99.6 = 0.4°C

80. Answer (3)

Hint: Correction term of pressure for real gas molecules is $\frac{an^2}{V^2}$

Sol.: Unit of correction term of pressure is the unit of pressure i.e. atm.

81. Answer (3)

Hint: During random motion of gas particles, they collide with each other and with the walls of the container.

Sol.: Pressure of gas is due to collisions of molecules with the wall of the container.

82. Answer (4)

Hint: $P_{He} = P_T \times X_{He}$

Sol.: If masses of both He and Ne gases are w(g) then

$$X_{He} = \frac{\frac{w}{4}}{\frac{w}{4} + \frac{w}{20}} = \frac{5}{5+1} = \frac{5}{6}$$

$$P_{He} = P_T X_{He} = \frac{5}{6} \times 18 = 15 \text{ atm}$$

83. Answer (2)

Hint: Both at STP and SATP, pressure is 1 bar.

Sol.: At SATP, P = 1 bar and T = 298.15 K

84. Answer (4)

Hint and Sol.: Due to presence of large inter-molecular distances among gas molecules, gases generally possess larger volume and smaller density than both solids and liquids.

85. Answer (2)

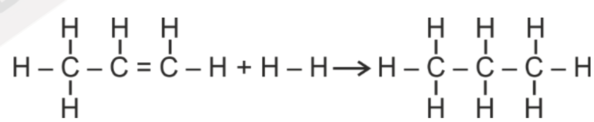
Hint and Sol.: Dipole-dipole interaction energy between stationary polar molecules in solids $\propto \frac{1}{r^3}$.

SECTION - B

86. Answer (4)

Hint: Δ_rH = ∑BE (Reactants) – ∑BE (Products)

Sol.:



Δ_rH = {6BE (C – H) + BE (C – C) + BE (C = C) + BE (H – H)} – {8BE (C – H) + 2BE (C – C)}

= BE (C = C) + BE (H – H) – 2BE (C – H) – BE (C – C)

= 600 + 430 – 2 × 410 – 330

= –120 kJ mol^{-1}

87. Answer (2)

Hint: $\Delta G° = \Delta H° - T\Delta S°$ and $\Delta H° = \Delta U° + \Delta n_gRT$

Sol.:

- $\Delta H° = \Delta U° + \Delta n_gRT$

  = – 10 + (0)RT = –10 kJ

- $\Delta G°$ = – 10 – 298 × 10^{-3} × (– 40) = 1.92 kJ

88. Answer (2)

Hint: $\Delta G = \Delta G° + 2.303\ RT\log Q$ and

$\Delta G° = -RT\ln K$

Sol.:

- $\Delta G° = \Delta H° - T\Delta S° = -RT\ln K$
- $\Delta G = \Delta G° + RT\ln Q$

$= -RT\ln K + RT\ln Q = -RT\ln\left(\frac{K}{Q}\right)$

- $\Delta G° = -RT\ln K_P \Rightarrow K_P = e^{-\Delta G°/RT}$

89. Answer (3)

Hint: NaCl is solid, H_2O is liquid while NH_3 is gas at room temperature.

Sol.: Order of enthalpy of vapourization,

$NH_3 < H_2O < NaCl$

90. Answer (1)

Hint: Enthalpy of neutralization of strong acid with strong base is –57.1 kJ eqv^{-1}.

Sol.: Ionization enthalpy of weak monoacidic base = – 47.1 – (– 57.1)

= – 47.1 + 57.1

= 10 kJ mol^{-1}

91. Answer (3)

Hint: ΔG is an additive property.

Sol.:

(i) $A \longrightarrow B$, $\Delta G_1 = -700$ kcal

(ii) $C \longrightarrow B$, $\Delta G_2 = +800$ kcal

on applying (i) – (ii), $A \longrightarrow C$, $\Delta G = -1500$ kcal

92. Answer (2)

Hint: Thermochemical reactions can be added or subtracted algebraically on the basis of ΔH.

Sol.: Applying 3(i) + (ii) – (iii)

$2A \longrightarrow E + 4C$,

$\Delta H = 900 - 120 - 500 = 280$ kJ mol^{-1}

93. Answer (1)

Hint: Entropy change,

$$\Delta S = nC_V \ln\left(\frac{T_2}{T_1}\right) + nR\ln\left(\frac{V_2}{V_1}\right)$$

Sol.: For isothermal process, $T_2 = T_1$

So, $\Delta S = nR\ln\left(\frac{V_2}{V_1}\right)$

94. Answer (1)

Hint: With increase of temperature, randomness of ideal gases increases.

Sol.: Smaller is the value of pressure, higher will be the randomness. So, at 1 atm pressure and at 373°C, randomness will be highest.

95. Answer (3)

Hint: At equilibrium, $\Delta G = 0$

Sol.: At equilibrium, entropy is maximum while Gibbs' free energy change is zero.

96. Answer (2)

Hint: $\Delta H = \Delta E + \Delta n_g RT$

Sol.: For given reaction, $\Delta n_g = 3$

So, $\Delta H = \Delta E + 3 \times R \times 300$

Or $\Delta H - \Delta E = 900R$

97. Answer (3)

Hint: $\Delta G° = -2.303\ RT\log K_p$

Sol.: $\Delta G° = -2.303 \times 8.314 \times 298 \times \log 100$

98. Answer (2)

Hint: Rate of effusion (r) $\propto \left(\frac{1}{\text{Molar mass}}\right)^{\frac{1}{2}}$

$\propto \frac{1}{\text{time}}$

Sol.: $\frac{r_1}{r_2} = \frac{t_2}{t_1} = \sqrt{\frac{M_2}{M_1}} \Rightarrow 4 = \sqrt{\frac{M_2}{2}}$

$M_2 = 16 \times 2 = 32$ g mol^{-1}

So, possible formula of gas is $O_2(g)$.

99. Answer (4)

Hint: Gases do not have a definite shape and volume.

Sol.:

- Increase of pressure increases the boiling point of liquids and this concept involves in pressure cooker.
- Expansion of gas at constant temperature does not result in increase of number of gas molecules.

100. Answer (2)

Hint: At constant temperature, $P_1V_1 = P_2V_2$

Sol.:

- $P_1 = 740$ mm Hg, $V_1 = 400$ ml
- $P_2 = 800$ mm Hg, $V_2 = ?$
- $P_1V_1 = P_2V_2 \Rightarrow 740 \times 400 = 800 \times V_2$

  $V_2 = 370$ ml

[BOTANY]

SECTION - A

101. Answer (4)

Hint: All tissues outside vascular cambium constitute bark.

Sol.: Bark does not include xylem. It includes cork cambium, pericycle and phellem.

102. Answer (2)

Hint: Heartwood is also called duramen.

Sol.: Duramen is centrally located secondary xylem.

103. Answer (1)

Hint: Stomata are also found in monocots.

Sol.: Both stomata and lenticels are involved in loss of water in the form of vapour. They are also involved in gaseous exchange.

104. Answer (2)

Hint: Phellogen is extra-stelar cambium.

Sol.: Phellogen is formed by dedifferentiation of the cell of cortex.

105. Answer (3)

Hint: Secondary growth in root is not affected by seasonal pattern.

Sol.: Spring wood is also called early wood and it has lesser density.

106. Answer (1)

Sol.: Bulliform cells are empty, colourless cells of upper epidermis of monocot leaves.

107. Answer (1)

Hint: Isobilateral leaves are found in monocots.

Sol.: Isobilateral leaves have stomata on both the surfaces. They have bundle sheath cells and have cuticle on epidermis.

108. Answer (1)

Hint: Ground tissue is not differentiated in monocot stem.

Sol.: Dicot stem has vascular bundles arranged in a ring while in monocot stem, they are scattered.

109. Answer (2)

Hint: Open vascular bundles have cambium.

Sol.: Dicot stem has conjoint, collateral open vascular bundles.

110. Answer (4)

Hint: Casparian strips makes endodermis impervious to water.

Sol.: Casparian strips are seen in roots only.

111. Answer (3)

Hint: Trichome and root hair both are epidermal outgrowths.

Sol.: Trichomes are soft or stiff, unicellular or multicellular epidermal outgrowths.

112. Answer (4)

Hint: Bast fibre is another name of phloem fibre.

Sol.: In phloem, sieve tubes, companion cells and phloem parenchyma are living while phloem fibre is dead. In xylem only ray parenchyma is living.

113. Answer (1)

Hint: Protoxylem and metaxylem both are primary xylems.

Sol.: Metaxylem is mature primary xylem with wider lumen.

114. Answer (4)

Sol.: Sclereids provide gritty texture to fruits.

115. Answer (4)

Hint: Mechanical tissues can be living or dead.

Sol.: Collenchyma is living mechanical tissue of plants.

116. Answer (2)

Hint: Lateral meristem are mostly secondary in origin.

Sol.: Intrafascicular meristem is a primary meristem. Rest all are secondary meristems.

117. Answer (4)

Hint: Cells of shoot apical meristem left in axil, called axillary meristem.

Sol.: Axillary bud is primary meristem and can form a flower or branch of stem.

118. Answer (3)

Hint: Intercalary meristem is a primary meristem.

Sol.: Intercalary meristem is found intercalated between two permanent tissues and they increase length of plant.

119. Answer (2)

Hint: Plant cell wall is permeable to the solution.

Sol.: As the plasmolysed plant cell is placed in hypotonic solution, the solute of solution present between cell wall and plasma membrane will move towards the solution A due to permeability of cell wall.

120. Answer (2)

Hint: Osmotic pressure is equivalent to the osmotic potential, but the sign is opposite.

Sol.: Factors such as concentration of solute particles, ionization of the solute molecule, temperature etc. affect the osmotic pressure.

121. Answer (4)

Hint: Osmosis is a special type of diffusion.

Sol.: Osmosis is a special type of diffusion of water across a differentially or semipermeable membrane. The plant cell wall is freely permeable to water and substances in a solution.

122. Answer (4)

Hint: Water moves from its higher water potential to its lower water potential.

Sol.: According to the question

$\Psi_w(A) = -7 + 2 = -5$ bar

$\Psi_w(B) = -9 + 3 = -6$ bar

As the water flows from both cell A and cell B to cell C, the water potential of cell C should be the lowest.

The value of Ψ_w in option (4) is the lowest *i.e.*, $-9 + 2 = -7$ bar.

123. Answer (2)

Hint: Water potential of pure water at standard temperature, which in not under any pressure is taken to be zero.

Sol.: Solute potential of a solution is always negative. For a solution at atmospheric pressure, water potential is equal to solute potential. If the pressure greater than atmospheric pressure is applied to a solution, its water potential increases.

124. Answer (4)

Hint: Minerals are present in the soil as charged ions.

Sol.: Minerals are absorbed by the roots actively because they are present in soil in lower concentration and as charged ions.

125. Answer (1)

Hint: Cell of inner boundary of the cortex have many transport proteins.

Sol.: Transport proteins of endodermal cells are control points, where plants can adjust the quantity and type of solutes that reach the xylem according to its variable requirement.

126. Answer (3)

Hint: Along with inorganic nutrients, xylem transports organic materials too.

Sol.: Small amount of phosphorus and sulphur as organic compounds transport through xylem.

127. Answer (4)

Hint: In active transport, materials move across the membrane with the help of mobile carrier protein and ATP.

Sol.: In active transport, pumps transport substances from their low concentration to high concentration *i.e.*, against concentration gradient. So, it is an uphill transport.

128. Answer (1)

Hint: In symport, molecules move in the same direction.

Sol.: Symport is the transport of two types of molecules across the membrane in the same direction.

129. Answer (3)

Hint: Proteins form channels in the membrane of some cell organelles and some bacteria, allowing molecules to pass through.

Sol.: The porins are proteins that form large pores in the membranes of the plastids, mitochondria and some bacteria.

130. Answer (1)

Hint: Carbohydrate in the form of sucrose which is soluble in water is transported in plants through phloem.

Sol.: Phloem sap is mainly water and non-reducing sugar *i.e.*, sucrose. Hormones, amino acids and other sugars are also translocated through phloem.

131. Answer (4)

Hint: Heartwood comprises of dead elements with highly lignified walls.

Sol.: The heartwood does not conduct water but it gives mechanical support to the stem. Deposition of organic compounds like tannins, resins, oils, gums, aromatic substances and essential oils in heartwood make it hard, durable and resistant to the attacks of microorganisms and insects.

132. Answer (1)

Hint: Interfascicular cambium lies between two intrafascicular cambia.

Sol.: In dicotyledonous stem, the cells of medullary rays, adjoining the two intrafascicular cambia become meristematic and form the interfascicular cambium.

133. Answer (3)

Hint: Conjunctive tissue is present in between the patches of xylem and phloem.

Sol.: The parenchymatous cells which lie between the xylem and the phloem of both monocotyledonous and dicotyledonous roots are called conjunctive tissue.

134. Answer (3)

Hint: Secondary growth occurs when the vascular bundles are open.

Sol.: Open vascular bundles have cambium between xylem and phloem. Such vascular bundles because of the presence of cambium possess the ability to form secondary xylem and phloem tissues, and hence are called open vascular bundles.

135. Answer (2)

Hint: Cells of pith in primary stems and roots are thin walled.

Sol.: Parenchymatous cells are usually present in cortex, pericycle, pith and medullary rays, in the primary stems and roots.

SECTION - B

136. Answer (1)

Hint: Pericycle is outer most layer of stele.

Sol.: In monocots, pericycle forms lateral roots only. Monocots lack cambium.

137. Answer (2)

Hint: Tyloses are tracheal plugs found in heartwood.

Sol.: Tyloses are balloon-like swellings of xylem parenchyma cells in the lumen of vessels.

138. Answer (1)

Hint: Complementary cells are loosely-arranged thin-walled parenchymatous cells present in lenticels.

Sol.: Cork cambium some times produces complementary cells instead of thick walled cork cells. The increased number of such type of cells forms lenticels.

139. Answer (4)

Hint: Epidermis of root is also called epiblema. Bulliform cells are colourless.

Sol.: Guard cells possess chloroplasts and regulate the opening and closing of stomata.

140. Answer (2)

Hint: Roots are underground parts of plant.

Sol.: Outside of the epidermis is often covered with cuticle in aerial parts of plants. This covering of cuticle is absent in roots.

141. Answer (2)

Hint: Translocation of food from leaves to other parts of plants occurs through phloem.

Sol.: Transport of minerals and water that occurs through xylem is due to transpiration. Due to this process, water supply for photosynthesis is maintained. It also lowers the temperature of leaf surface.

142. Answer (3)

Hint: There is more attraction between molecules in liquid phase as compared to gas phase.

Sol.: Surface tension is created by the attraction between molecules. The force of attraction between molecules in liquid phase is more than in gas phase. Therefore, the surface tension is more in liquid phase as compared to gas phase.

143. Answer (1)

Hint: Guttation occurs when the root pressure is high and transpiration is low.

Sol.: The process of exudation of liquid drops from the margin of the leaves is called guttation.

144. Answer (3)

Hint: Casparian strips are present in the endodermis.

Sol.: The inner boundary of the cortex *i.e.*, endodermis is impervious to water because of a band of suberized matrix called the casparian strip.

145. Answer (3)

Hint: Apoplast pathway includes non-living parts of plant body.

Sol.: Symplastic pathway of water movement includes living parts of plant body. It is slightly slower pathway.

146. Answer (2)

Hint: Bulliform cells are found in grasses. These are certain adaxial epidermal cells along the veins which modify themselves into large, empty, colourless cells.

Sol.: When the bulliform cells in the leaves absorbs water and become turgid, the leaf surface is exposed. When they become flaccid due to water stress, they make the leaves curl inwards to minimise water loss.

147. Answer (4)

Hint: The cells of the endodermis in stem are rich in starch grains.

Sol.: In dicotyledonous stem, the cells in the innermost layer of the cortex called the endodermis are rich in starch grains and this layer is also referred to as the starch sheath.

148. Answer (1)

Hint: Cork cambium is extra-stelar cambium.

Sol.: Cork cambium or phellogen also known as extra-stelar cambium, develops usually in the cortex region during secondary growth in dicotyledonous plants.

149. Answer (3)

Hint: In flaccid condition of a cell, its DPD = OP.

Sol.: The relation among DPD, OP and TP is DPD = OP – TP.

150. Answer (1)

Hint: Imbibition is a special type of diffusion.

Sol.: In imbibition, molecules move from its higher concentration to its lower concentration. This process does not require the energy of ATP.

[ZOOLOGY]

SECTION - A

151. Answer (2)

Hint: Osmolarity more than 300 mOsmol L^{-1}

Sol.: In descending limb of loop of Henle, the osmolarity of filtrate changes from 300 mOsmol L^{-1} to 1200 mOsmol L^{-1}.

152. Answer (2)

Hint: Width is more than 5 cm

Sol.: The adult human kidney measures:

Length	Width	Weight
10-12 cm	5-7 cm	120-170 gm

153. Answer (2)

Hint: Hyponatremia

Sol.: Aldosterone stimulates the reabsorption of Na^{+} and water from DCT and collecting tubule. This leads to an increase in blood volume and blood pressure.

154. Answer (1)

Hint: Part of ANS which works in resting condition

Sol.: Parasympathetic nerve fibres – Constriction of urinary bladder and relaxation of internal urethral sphincter

Sympathetic nerve fibres – Dilation of urinary bladder and constriction of internal urethral sphincter.

155. Answer (3)

Hint: Hyperglycemia

Sol.: Presence of ketone bodies and glucose in urine are associated with diabetes mellitus.

Pyelonephritis – Inflammation in renal pelvis

Glomerulonephritis – Inflammation in glomeruli.

156. Answer (2)

Hint: Associated with uricotelism

Sol.: Sweat produced by sweat glands is a watery fluid which contains NaCl, small amount of urea, amino acids and glucose, etc.

157. Answer (1)

Hint: 1200 mOsmol/L

Sol.: Human kidneys normally produce urine about four times more concentrated than the initial filtrate formed.

158. Answer (4)

Hint: Not considered as a part of renal tubule

Sol.: Aldosterone acts on DCT and collecting duct, so conditional reabsorption of salt and water takes place under the influence of aldosterone in these parts.

159. Answer (4)

Hint: About 20 percent of renal plasma flow

Sol.: Net filtration pressure = GHP – (BCOP + CHP)

where, GHP – Glomerular hydrostatic pressure

BCOP – Blood colloidal osmotic pressure

CHP – Capsular hydrostatic pressure

160. Answer (3)

Hint: Structure which emerges from glomerulus

Sol.: Efferent arteriole emerges from glomerulus and forms a fine capillary network around the renal tubule called peritubular capillaries. A minute vessel of this network runs parallel to the Henle's loop forming a U-shaped vasa recta.

161. Answer (2)

Hint: Lizards are uricotelic

Sol.:

Bony fishes	–	Ammonotelic
Land snails and reptiles	–	Uricotelic
Land amphibians	–	Ureotelic
Urea formation	–	Liver

162. Answer (4)

Hint: High blood pressure stimulates its secretion

Sol.: ANF causes vasodilation, decrease blood pressure and opposes the regulation by RAAS. Angiotensin II is a vasoconstrictor and thereby increases the blood pressure.

163. Answer (4)

Hint: Double walled cup like structure

Sol.: PCT, DCT and collecting duct are responsible for the maintenance of ions and pH of blood. They do so by selective secretion and reabsorption.

164. Answer (2)

Hint: Present in inner wall of Bowman's capsule

Sol.: Podocytes create minute spaces for the filtration of blood into the Bowman's space.

Efferent arteriole carries blood away from glomerulus and maximum reabsorption of amino acids occurs in PCT.

165. Answer (2)

Hint: Part of nephron where maximum re-absorption takes place

Sol.: Nearly all of essential nutrients, and 70-80% of water are reabsorbed by PCT. The composition of glomerular filtrate is almost same as that of plasma except the proteins which are not present in glomerular filtrate.

ADH deficiency leads to polyuria.

166. Answer (1)

Hint: Less glomerular blood pressure

Sol.: The JGA plays a complex regulatory role. A fall in glomerular blood pressure can activate the JG cells to release renin which converts angiotensinogen in blood to angiotensin-I. ACE converts angiotensin-I to angiotensin-II. Angiotensin-II increases glomerular blood pressure.

167. Answer (2)

Hint: Muscular dystrophy is a genetic disorder.

Sol.:

- In myasthenia gravis, antibodies act against receptors present on sarcolemma for acetylcholine.
- Muscular dystrophy is a genetic disorder characterised by progressive degeneration of skeletal muscle.
- Tetany is due to low calcium in body fluids.
- Osteoporosis is an age-related disorder characterised by decreased bone mass.

168. Answer (4)

Hint: Joint present in hand

Sol.: Saddle joint is present between carpal and metacarpal of thumb side. Gliding joint is present between the carpals as well as between the tarsals. Hinge joint is present between femur and tibia forming knee joint. Ball and socket joint is present between humerus and glenoid cavity of pectoral girdle forming shoulder joint.

169. Answer (3)

Hint: Medial surface is closer to central axis of the body.

Sol.:

- Glenoid cavity is present below acromion process.
- Patella covers the knee ventrally.
- Fibula is present on the lateral aspect of hind limb.
- One end of clavicle articulates with acromion process of scapula and another end articulates with sternum.

170. Answer (2)

Hint: Phalangeal formula for hands is 2,3,3,3,3

Sol.: In digits of one forelimb, 14 phalanges are present. So, in both the forelimbs 28 bones are present.

171. Answer (1)

Hint: Number of cervical vertebrae in sloth

Sol.: Almost all mammals including human beings have seven cervical vertebrae. Other characteristic features of mammals are:

- Presence of mammary glands.
- Presence of pinna, hair on body, sweat glands and a four-chambered heart.

172. Answer (4)

Hint: Hyoid bone

Sol.: Human skull is dicondylic. Atlas (first vertebra) articulates with two occipital condyles. Only parietal and temporal bones are paired cranial bones.

173. Answer (3)

Hint: Example of freely movable joint

Sol.:

- In fibrous joints (e.g., sutures of skull), bones are fused with the help of dense fibrous connective tissues.
- In cartilaginous joints (e.g., pubic symphysis), the bones involved are joined together with the help of cartilages.
- In synovial joints (e.g., carpo-metacarpal joint, gliding joint, etc.), synovial fluid is present between articulating surfaces of the two bones.

174. Answer (4)

Hint: Length of A-band remains same during muscle contraction.

Sol.: Actin and myosin filaments do not shorten during muscle contraction.

Contraction of a muscle fibre takes place by the sliding of the thin filaments over the thick filaments.

175. Answer (3)

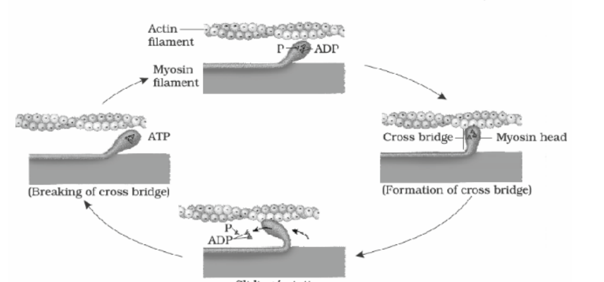
Hint: Storehouse of calcium ions in skeletal muscle fibres

Sol.: Myoglobin content, number of mitochondria and amount of stored oxygen is high in red muscle fibres as compared to white muscle fibres but amount of sarcoplasmic reticulum is high in white muscle fibres.

176. Answer (2)

Hint: Cross bridge formation requires energy

Sol.:



177. Answer (1)

Hint: Function of troponin

Sol.: In the resting state of skeletal muscle fibre, a subunit of troponin (troponin-I) along with tropomyosin masks the active binding sites for myosin on the actin filaments.

178. Answer (2)

Hint: 'H'-zone

Sol.: Length of I-band, H-zone and sarcomere decreases during muscle contraction while length of A-band remains same.

179. Answer (4)

Hint: 'Z' line is elastic

Sol.:

- 'Z' line is an elastic fibre which bisects 'I' band containing actin filaments.
- 'M' line is a thin fibrous membrane.
- Sarcomere is the portion of myofibrils between two successive 'Z' lines.

180. Answer (3)

Hint: Endoplasmic reticulum

Sol.:

- Sarcoplasmic reticulum (endoplasmic reticulum) is the store house of calcium ions.
- Plasma membrane of muscle fibre is called sarcolemma.
- Cytoplasm of muscle fibre is called sarcoplasm.
- In involuntary muscles, ECF is the main source of calcium ions.

181. Answer (3)

Hint: Muscle fibres are in polarised state during resting condition.

Sol.:

- Muscles are mesodermal in origin.
- Muscles constitute 40-50% of the body weight in an adult human.
- Skeletal muscles (voluntary striated muscles) are primarily involved in locomotory actions and change of body postures and not in all movements.
- Muscle fibres show excitability, conductivity, extensibility, elasticity and contractility.

182. Answer (2)

Hint: Striations are absent

Sol.: Muscles have been classified using different criteria, namely location, appearance and nature of regulation of their activities.

Parameter	Types of muscles		
Location	Skeletal	Visceral	Cardiac
Appearance	Striated	Non-striated	Striated
Nature of regulation	Voluntary	Involuntary	Involuntary

183. Answer (3)

Hint: Spongocoel is lined by flagellated cells.

Sol.:

- Fallopian tubes are lined by ciliated columnar epithelium. Ciliary movement helps in passage of ovum through oviduct.
- Flagellar movement helps in maintenance of water current in the canal system of sponges.
- Macrophages and leucocytes exhibit amoeboid movement.
- Movement of our limbs, jaws, tongue, etc, require muscular movement.

184. Answer (2)

Hint: Change in place or location of whole organism is called locomotion.

Sol.: All locomotions are movements but all movements are not locomotions. The voluntary movements which result in change of place or location of whole organism is called locomotion.

185. Answer (2)

Hint: Feeding

Sol.:

- In *Paramoecium*, cilia helps in locomotion as well as movement of food through cytopharynx.
- Pseudopodia are formed by the streaming of protoplasm, e.g., *Amoeba.*
- Tentacles are not found in *Paramoecium.* Tentacles help in locomotion and capturing of prey in *Hydra*.
- Cytoskeletal elements are involved in amoeboid movement.

SECTION - B

186. Answer (2)

Hint: Insoluble mass of crystallised salts

Sol.: In renal calculi, stone or insoluble mass of crystallised salts (oxalates, etc) are formed within the kidney

187. Answer (3)

Hint: Low threshold value substance.

Sol.: Nitrogenous wastes like urea are reabsorbed passively from renal tubule whereas glucose and ions like Na^+ are reabsorbed actively.

188. Answer (3)

Hint: Exhibit osmolarity 200 $mOsmL^{-1}$.

Sol.: Conditional reabsorption of water occurs under the influence of ADH in DCT and collecting duct. Collecting duct is not included in renal tubule.

189. Answer (2)

Hint: Possess filtration slits

Sol.: The epithelial cells of Bowman's capsule called podocytes are arranged in an intricate manner so as to leave some minute spaces called slit pores or filtration slits.

190. Answer (4)

Hint: Short loop of Henle

Sol.: In juxtamedullary nephrons, the loop of Henle is long as compared to cortical nephrons and they possess vasa recta which is absent in cortical nephrons.

191. Answer (3)

Hint: Land insects

Sol.: Cat – Ureotelism

Salamander – Ammonotelism

Cockroach – Uricotelism

Earthworm – Ammonotelic in water and ureotelic in moist soil.

192. Answer (2)

Hint: 20% of cardiac output is filtered per minute

Sol.: About 1100 - 1200 mL of blood is filtred by the kidneys per minute which constitutes roughly $1/5^{th}$ of the blood pumped out by each ventricle of the heart in a minute.

The amount of the filtrate formed by the kidneys per minute is called glomerular filtration rate (GFR). GFR in a healthy individual is about 125 mL/min.

193. Answer (4)

Hint: Less than 300 mL/minute

Sol.: Our lungs remove large amounts of CO_2 approximately 200 mL/ minute or 12000 mL/hour.

194. Answer (1)

Hint: Relaxation of urethral sphincter

Sol.: During micturition, the CNS passes on motor messages to initiate the contraction of smooth muscles of the bladder and simultaneous relaxation of the urethral sphincter causing the release of urine.

195. Answer (4)

Hint: Ileum is a part of small intestine

Sol.:
- Ossein protein is present in matrix of bones.
- Myosin is a contractile protein.
- Ilium, ischium and pubis fuse to form coxal bone. Ileum is the longest part of small intestine.

196. Answer (2)

Hint: Acetylcholine receptors are present on sarcolemma.

Sol.: Muscle contraction is initiated by a signal sent by the CNS via a motor neuron.

A neural signal reaching to neuromuscular junction releases acetylcholine. Acetylcholine binds with its receptors present on sarcolemma. As a result, action potential generates in the sarcolemma.

197. Answer (2)

Hint: Articular cartilage

Sol.: At the ends of long bones, hyaline cartilage is present. Matrix of cartilage is slightly pliable while that of bone is non-pliable.

198. Answer (4)

Hint: Foramen magnum is present at the base of skull.

Sol.: Base of the skull has a large opening called foramen magnum through which the brain communicates with the spinal cord.

Spinal cord is present in neural canal of vertebral column.

199. Answer (4)

Hint: Vertebrosternal ribs are true ribs.

Sol.:

- First seven pairs of ribs are true ribs (vertebrosternal ribs). Dorsally, they are attached to the thoracic vertebrae and ventrally connected to sternum with the help of hyaline cartilage.
- The 8^{th}, 9^{th} and 10^{th} pairs of ribs do not articulate directly with the sternum but join the seventh rib with the help of hyaline cartilage. These are called vertebrochondral ribs (false ribs).
- Last 2 pairs (11^{th} and 12^{th}) of ribs are not connected ventrally and are therefore, called floating ribs or vertebral ribs.

200. Answer (2)

Hint: Equal to the number of palm bones in one fore limb

Sol.: The skull, vertebral column, sternum and ribs constitute axial skeleton. Hyoid, lacrimal, zygomatic and incus are skull bones. Axis is second vertebra. Scapula, carpals and ilium are bones of appendicular skeleton.

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